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THE PURPLE LEAF MOTH OF COCONUTS IN FIJI.

(*Levuana iridescens*, Bethune-Baker.)

By C. H. KNOWLES, B.Sc. (London), Superintendent of Agriculture.

(With notes by A. M. LEA, H. W. SIMMONDS, and from Departmental records.)

FOREWORD.

It is not yet known how the Purple Coconut Moth (*Levuana iridescens* Bethune-Baker) reached Fiji. That it is not indigenous to these islands is practically certain.

The first mention of its presence was made by B. Seemann* sixty-four years ago, when in 1860 he wrote on Fiji Flora and the suitability of the islands for coconut growing.

> Only Bau, Viwa, and the districts adjacent form an exception, trees as soon as they have reached a certain height become diseased; their leaves look as if dipped in boiling water and their fruits are few in number, poor, and often drop off before they arrive at maturity.

Eleven years after, in 1871, J. Horne,† Director of Woods and Forests and Botanical-Gardens, Mauritius, wrote on this subject.

> Excepting Vitilevu, the coconut thrives remarkably well in all parts of Fiji, and the trees are generally as healthy and fruitful as in the best plantations I have seen in the Seychelles or Ceylon. In Vitilevu the leaves of the trees are attacked by a caterpillar to such an extent as to injure the health of the trees and prevent it bearing fruit abundantly. The ravages of these caterpillars were noticed in some of the other islands, but they seem to be kept down by birds or insects and prevented from increasing to any injurious extent. The subject ought to be investigated in order that a remedy may be found and applied . . . . . the Government and the Fiji Agricultural Association might take up this matter together.

For forty years or more, after the warning had been given, little or nothing appears to have been done to give effect to Horne's recommendation.

The main island, Vitilevu, where the moth was at work received little attention from coconut planters and all further development in building up a coconut industry was directed to the outlying islands of the Group, which were uninfected.

Meantime the injudicious introductions from India of the Mynah bird (*Acritoceres tristis*) and of the Mongoose, for controlling the grasshopper and the rat pests on sugar plantations and the rapid increase of these, had a detrimental result on ground and some insectivorous birds and these

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* B. Seemann: *Mission to Fiji.* † J. Horne: *A Year in Fiji*, pp. 8–30, 174.

gradually became scarcer as also did lizards, which are essentially insectivorous and were then very numerous. As time went on, the harm done to the palm trees by the purple coconut moth became more and more evident. The Department of Agriculture in 1906 took steps to have the moth identified. Later on in 1911, Mr. F. P. Jepson, the Government Entomologist, recorded in his notes on the pest and a few years after Mr. C. H. Knowles, then Superintendent of Agriculture, issued a resume of the known observations on the pest which are now re-printed.*

Since then little was done in connection with the problem of controlling this pest, until last year when the Government seized with the necessity of opposing a front to the encroachments of the moth, decided to throughly investigate the practicability of introducing from abroad natural checks to control it.

Mr. H. W. Simmonds, the Acting Entomologist, was commissioned to visit the New Hebrides, Solomons, and the Mandated Islands adjoining the coast of New Guinea, where it was thought, indications might be found leading up to the discovery of the natural habitat of the *Levuana* moth.

Although time and opportunity did not permit more than a rapid inspection being made of the coconut plantations in the territories named, a useful survey resulted of the pests affecting the coconut plantations there, but no trace whatever came under observation either of the *Levuana iridescens* or of any allied Zygænid moths.

At the same time, public opinion in Fiji became alarmed at the rapid spread and developments of the moth, which for a long time restricted to Vitilevu, the mainland of the Group, had of recent years reached islets in the vicinity of its coast whence if spread over the bigger island of Motoriki in close proximity of the island of Ovalau, of which Levuka is the port and business centre and where the greater portion of the traffic with the islands of the Group radiates.

Ovalau itself becoming infested at this stage, the Government decided to further extend the efforts to control the pest.

In December, 1923, the Legislature on the Motion of the member for Lau and Lomaiviti, Sir Maynard Hedstrom, approved of the imposition of an export tax of 2s. 6d. per ton on copra to provide funds for expert research work, with a view to the discovery of an effective method of combating the danger.

A Committee was appointed to organise the research work and carry out the intention of the Legislature. The personnel consists of Sir Maynard Hedstrom (on leave), E. Duncan, Esq., R. Crompton, O.B.E., and the Superintendent of Agriculture as Chairman.

A reward of £5,000, payable from the public funds of the Colony, was offered for the discovery of an effective method of controlling the moth, the conditions under which the reward may be deemed to have been earned, to be drawn up by the Committee and to be approved by the Legislative Council.

The Committee at once opened communications with leading entomologists in Australia, who may be entitled to such period of long leave as would permit them to carry out under a considered plan, an exploration for the natural habitat of the *Levuana* moth and of its natural parasites. The Secretary of State was also requested to inquire about an entomologist with tropical experience for appointment under conditions offered to such searchers.

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* F. P. Jepson, 1911. "Report on Economic Entomology," Council Paper 25. C. H. Knowles, 1919. "The Small Leaf Moth of Coconuts in Fiji," Bulletin No. 12

So far the services of Mr. A. M. Lea, Government Entomologist of South Australia were kindly loaned by the Board of Governors of the Adelaide Museum, and Mr. Lea has already entered on this work in conjunction with Mr. H. W. Simmonds, Entomologist of the Department of Agriculture, Fiji.

The supplementary observations recorded by these entomologists and those of the officers of the inspection staff are given in the context, of the Departmental Bulletin No. 12 now reprinted. The knowledge therefore of the life history of the moth as a result of these recent investigations being much advanced.

The Committee is now corresponding with the Curators and inviting the co-operation of Directors of Museums of Natural History, leading entomologists and naturalists all the world over, to gain information that may lead to a successful search for the habitat of this Small Purple Moth of the Coconut.

The Department of Agriculture in the Federated Malay States and Straits Settlements through its entomologists has furnished valuable information regarding a closely allied coconut moth *Zygænid, Brachartona catoxantha*, which is controlled by several internal parasites (an Ichneumon, a Brachonid, a Tachinid, and a Phorrid fly) and also by a parasitic fungus, *Botrytis necans*.

This clue is, so far, the most promising this Committee has had, regarding the whereabouts of a closely allied *Zygænid* showing features resembling those of the *Levuana iridescens* Beth.-Baker, and the Department of Agriculture is in close touch with the Federated Malay States' Entomologists, on this subject.

It seems reasonable to think, that the territories where allied *Zygænid* moths are found—India to Cochin China—offer a promising field for exploration and it is one which will certainly not be overlooked in the efforts to locate the object the Government of Fiji has in view.

That this purple coconut moth threatening to set back the development of the copra industry in Fiji, may in its natural home prefer other plant food is quite possible, but a close scrutiny of palms of all kinds in general may lead to its discovery or to that of closely allied species and such information promptly transmitted to the Department of Agriculture, Suva, Fiji, will be gratefully acknowledged.

A. DESPEISSIS,
Acting Superintendent of Agriculture,
Chairman, *Levuana* Control Committee.

30th June, 1924.

THE coconut palm does not regularly bear satisfactorily on the Island of Vitilevu. The leaves are often brownish-white in appearance and, when examined closely, it is seen that this is due to the removal of the green cellular matter, from the under surface, leaving only the midribs and the upper epidermis or skin of the leaflets. It is now recognised that the failure of the palms to fruit properly is due to these attacks on the leaves.

THE CAUSE.

The larvæ of a small moth feed on the coconut leaflets, eating away the lower epidermis and the cells containing the green colouring matter. The larvæ move along the leaflets in tracks parallel to the veins and, when

plentiful, practically the whole material except the midrib and the upper epidermis is consumed.*

* The tallest trees are usually the first attacked and not until the leaves of these first ones are practically destroyed, does the attack spread to the surrounding trees, when generally a number are attacked at once.

FIRST MENTION OF THE PEST.

J. Horne in " A Year in Fiji," published in 1880, page 8, says: " When on the Rewa, my attention was called to the unhealthy condition of some coconut trees, and here I noticed the injury was caused by an insect eating the undersides of the leaves, which then become covered with brown spots and wither and decay (if the ravages have been extensive) frequently before being fully expanded. From leaves being thus injured or destroyed, the trees are unable to bear fruit, and sometimes are entirely killed."

IDENTIFICATION OF INSECT.

When the writer arrived to take up the duties of Superintendent of Agriculture in 1905, his attention was early directed to this pest, and the habits of the animal were studied. Specimens were sent to England for identification and the reply received was that the insect was new to science. The moth was described by Mr. G. Bethune-Baker, of Birmingham, under the name of *Levuana iridescens* of the family *Zygænidæ*.†

† " Annals and Magazine of Natural History," Ser. 7, Vol. XVIII, Nov., 1906. Although described in 1906 as a Fijian insect, it is probable that it is really not a native of Fiji. Williams, 1850–1860, " Fiji and the Fijians," does not mention any coconut disease as doing damage. Seemann in 1860 reports that the trees in the neighbourhood of Bau and Viwa looked as if boiling water had been poured over them. An effect however also resulting from the attack of the leaf mining beetle *Promecotheca reichii*. Assuming the *Levuana* moth is an introduced pest, it is not unlikely that it was brought by trading vessels, prior to 1860 when its presence first came under notice. It is known the Tongans traded with Fiji for upwards of 200 years before. Then in the beginning of last century a good deal of trade was done in Sandalwood, Beche-de-mer or Trepang which was much in demand in the Chinese markets. Later, Commodore Wilkes in his first " United States Exploring Expedition " in 1840 refers to the extinction of the Sandalwood trade and to the traffic in the other goods named, being together with coconut oil and tortoise shell almost wholly carried on by American vessels from the port of Salem, Mass., U.S.A. Julius L. Brenchley: " The Cruise of the Curaçoa among the South Ses Islands, 1878." The last load of Sandalwood was shipped from this ill-fated island (Eromanga) in the " Amateur," Captain Long, for Hong Kong, August 29th, 1865. A Captain Edwards is spoken of, who in one year embarked 15,000 tons of Sandalwood and in a short time realised a fortune of £75,000.

The importation of foreign labour would appear to have commenced in 1864 (J. H. de Ricci, Fiji, 1875, page 170) when many labourers were introduced from the New Hebrides, 550 miles due West from Fiji and the Solomon and Gilbert Islands, 600 miles further away. By that time however, the *Levuana iridescens* was already in evidence in the vicinity of Bau and of the delta of the Rewa.

Description.—Mr. Bethune-Baker's description of the moth is as follows: " Antennæ bipectinated in both sexes. Palpi minute porrect. Mid and hind tibiæ with minute spurs. Wings moderately broad, expanding in the primary slightly outwards. Neuration: cell very long to nearly three-quarters of the wing in both wings; primaries, vein three given off from the angle, four and five about the angle, six and seven stalked from above the middle of the cell, eight given off from seven close to the termen, nine from the angle, ten midway between nine and eleven, eleven from beyond the centre of the cell; secondaries, vein two from well in front of the angle strongly bent downwards, three from the angle, four absent, five from the centre of the cell; seven absent, eight connected with the cell by a short bar. Type, *Levuana iridescens*, B.B."

DISTRIBUTION.

So far as is known the moth is recorded only from Vitilevu and a few small islands off its coast.*

* Now reported on the island of Beqa, Malolo in the Yasawas, Motoriki, Ovalau, Naiqani and small islands around, these outbreaks having been recorded since 1918.

FOOD PLANTS.

While the larvæ of this insect are particularly destructive to the coconut, they use other plants as food. So far palms only have been found to be attacked and they are as follows, in addition to the coconut:—

The Royal Palm (*Oreodoxa regia*).
The Sago Palm (*Sagus vitiensis*).
The Areca Nut (*Areca catechu*).†

† Also Fan Palms and Rattan Palms (*Calami*). Mr. Philips and Mr. H. W. Simmonds record seeing at Lautoka some *Levuana iridescens* on a banana plant growing beneath the coconut trees. They thought these had doubtless dropped from one of the affected palms, overhead, but they report that the grubs appeared to be feeding upon the banana leaves in their characteristic way, eggs were also found on the banana leaves. This is the only observation recorded.

LIFE HISTORY.

The female moth lays eggs in batches on the underside of the coconut leaflets. Oviposition takes place at an interval which varies from 7 to 70 hours after mating. The period of incubation is 7½ days.

Eggs.—The eggs are small oval-shaped bodies with a depression‡ in the upper surface and are yellowish and semi-transparent. They are laid in batches in parallel straight lines with the long axis of the egg parallel to the veins of the leaflet and to one another. Batches containing from 10–41 eggs have been counted. The eggs are about ½ mm. long and about half as broad; on approaching maturity, they become dark purple coloured.‖

‡ Depression present only shortly before the larvæ hatch.—A. M. Lea.

‖ To the naked eye, the eggs show a pinkish gloss, under magnification the sides are seen to be purplish. The larvæ eat their way out almost together and always at the same end, leaving most of the shell behind. The empty shells are white with an opalescent gloss. A number of clusters counted contained from 8 to 53, averaging 20 eggs.

Larvæ.—When full grown, the larva measures 12 mm. in length and 2 mm. in breadth. It consists of 13 segments, exclusive of the head. The 3 thoracic segments each bear a pair of jointed legs and the 6th, 7th, 8th, and 9th, each a pair of abdominal feet, the terminal segment bearing a pair of anal claspers. The larva is hairy.¶ Dorsally and laterally, each segment is provided with a pair of dark lines running down the length of the body. The larva is cream coloured and is broadest at the first thoracic segment, from which point it gradually tapers to the terminal segement.

¶ Not hairy in the usually accepted sence, the larvæ are clothed with rather short bristles in bunches (or fascicles), four bunches to each segment, with a few straggling bristles on the sides. The head is invisible from above, being concealed by a hood-like development of the front part of the body.—A.M.L.

The larva, when newly hatched, loses no time in commencing to feed and always feeds in a track parallel to the veins. At first the marks made by the larva are very narrow and short, but as it grows, the tracks become wider and longer and at last occupy very nearly the whole space between two " veins."

The larvæ complete their period in from 27–30 days, when (usually but not always) they crawl away from the leaflet on which they have been feeding down the leafstalk and take up a position within the area sheltered by the

fibrous matter which surrounds the base of each leafstalk. Here the larva spins a cream coloured silky cocoon, elliptical in shape, 10 mm. long and 5 mm. wide, attached by the whole area to the surface which the larva has selected to pupate on.

Occasionally pupation takes place on the under surface of the leaf itself or on the leafstalk. When numerous, the larvæ which pupate later, construct their cocoons partly or completely over those of the larvæ which have pupated earlier. The pupa measures 8 mm. long by 2·5 mm. wide, and is also cream-coloured.* The pupal stage occupies 13–14 days, when one end of the cocoon is opened on the line of attachment and the adult moth emerges, leaving the empty skin in the aperture of the cocoon.

* On becoming ready to change to the moth it becomes dark some parts appearing to be almost black.

Adult.—The adult moths are described by Mr. Bethune-Baker as follows:—

Levuana iridescens sp.—" Male and female.—Head and thorax steel-blue; abdomen and legs ochreous. Primaries deep unicolorous steely-blue without any markings; secondaries, iridescent steely-blue, semi-hyaline, especially from vein 1 c. to vein 5.

" Expanse, 16 mm.

" Habitat, Fiji Islands (Vitilevu).

" Type in my collection.

" The larva of this species has been doing great harm to the coconut palms in the islands, mining in the leaves and committing considerable destruction. Its life-history may prove to be one of exceptional interest if the information that I have at present proves to be correct in all its details. I am hoping, however, to clear one or two doubtful matters up in a few months, when I may bring the species forward again."

[*Note.*—" Mining " is an incorrect term to use for the method of feeding of this insect as it works *on the surface* and not *between* the two leaf surfaces.]

The actual life of the adult moth varies; mating appears to take place 18–19 hours after emergence from the puparium and the time from then to oviposition (in the case of female) varies from 7–70 hours. This time seems to be influenced by temperature, a high temperature tending to shorten the intervals both between emerging and mating, and between mating and laying the first egg.†

† As quoted: after mating the eggs are laid from ½ to 3 days, eggs hatch in from 7 to 8 days, larvæ feed from 27 to 30 days, pupal stage from 10 to 14 days, adult life from 3 to 11 days, total, 50½ to 66 days. If breeding is continuous, this would mean in 365 days, 6 to 7 broods a year, but this is extremely improbable.—A.M.L. On the other hand Mr. H. W. Simmonds remarks that the disease appeared on Motoriki in November, 1922, since which date it has been continuously under observation by Inspector C. T. McNamara, and during that time generation has succeeded generation without a break and it has gradually rolled across to and around both sides of Ovalau but has disappeared in some of its early places of attack as at Leleuvia and Cagalai. Do the moths themselves feed ? and if so, on what plants (the tongue when fully extended measures about half the length of the body). This is a point that could probably only be determined by night observations, so far as I have examined published material no night examinations have been made. Probably with a good acetylene light various details as to to their life-history, at present unknown, could be found out. I think that it is probable that night feeding insects would be seen attacking the larvæ. This I should like to find out before leaving to search for parasites, and is one of the features that must be looked into elsewhere than in Fiji; in the coastal districts of Australia, especially in Queensland for instance.—A.M.L.

EFFECT ON THE PALMS.

The effect on the palms of a pest of this kind practically is the same as defoliation. The leaves of a plant are the organs responsible for the

elaboration of substances taken from the soil and from the atmosphere, into materials which the plant can use to build up new tissues, and it is by the use of the substances manufactured in the leaves (and other green parts of the plant) that plants can grow and produce fruit. The reduction of the leaf area therefore reduces the amount of material available for the formation of new tissues and a regular defoliation will certainly result in the failure of the plant to produce fruit and may even bring about its death. A very striking demonstration of the effect of this moth came under notice a few years ago on the Ra coast, during a very bad attack of the pest on certain coconuts which were said to have been, until just previously, free from the pest for some years.

The whole of the leaves had the brownish-white appearance due to total removal of the green cellular matter. The lower fruit bunches consisted of quite a respectable number of coconuts. Higher up, however, it was seen that the number of coconuts in the bunches was much smaller and the upper fruit stalks carried no fruit whatever. It was clear that the palms, before the attack, had been bearing satisfactorily, and it is reasonable to suppose that as the damage done by the larvæ increased, the trees produced less fruit, and finally ceased to bear.

On one of these palms, the larvæ were found to be eating the green outer covering of the young nuts, presumably owing to their being too plentiful to find sufficient food on the leaves. In 1917 the Superintendent of Agriculture investigaed an attack on certain coconuts between Lautoka and Nadi which, it was reported, had been killed by the Rhinoceros beetle. No signs of the Rhinoceros beetle however were found, and indeed it was certain that this insect had not been present. The leaves on the trees in question had been getting smaller and smaller and one tree had died. The only signs of insect attack were caused by *Levuana* and the damage to the trees had undoubtedly been caused solely by *Levuana*. It is clear that repeated attacks of this pest on trees, particularly when these latter are not very favourably situated, will cause the leaves to become smaller and smaller and at last the tree will die.*

* There seems there is present an instinct to migrate in the females, when food becomes scarce, and that, owing to the feeble nature of the insects flying powers, such migration will follow the direction of the wind at the moment, if blowing with any strength. This fact throws light on the disappearance and reappearance of this pest in various districts in Vitilevu.—H.W.S.

VARIATION IN SEVERITY OF THE ATTACKS.

Quite early in the investigation of the habits of this pest, it was noted that trees which are badly attacked at one time, so that not a green leaf is to be seen, are subsequently perfectly free form all signs of the pest; and for some years in the palms under observation, the pest was found to attack the plants at about the same time each year, commencing about August. It was hoped that it would prove to be the case that the insect only attacked the trees at a regular season, when it would be possible that it might pass the intervening period in some situation or under some conditions which would enable it to be more easily dealt with than when on the palms. Further observation in other parts of the island, however, showed the insect to be plentiful at other seasons, and it has since been found to be present in one particular patch of coconuts right through the year. There is, however, a considerable variation in the prevalence of the pest at times, although the conditions responsible for this variation are not yet understood The rather sudden increase in the severity of the attacks of the pest has in more than one instance been found to be due to the pest sweeping over

the place. For example, observation showed distinct evidences that an attack swept along from the neighbourhood of Penang on the Ra coast, through Caboni, Tavua, Ba to Lautoka.

The increase in the number of the insects to a maximum and the subsequent decrease to practically the disappearance of the pest, is certainly partly dependent on the food supply. So long as there is sufficient food, the pest can increase, but subsequently, when all is consumed, as can quickly be the case with coconut leaves which are only put out slowly, the pest must die off. And of course it is possible that all variations are due to similar waves, but it is likely that other factors play a part besides the mere progression of a swarm of the insects passing from place to place.

Indeed it cannot yet be accepted that it is a regular habit of the moth to embark on long flights.* As a rule the adult insects are to be seen hovering round the palms on which they lived as larvæ. But in a grove of coconuts, it is rare to find a palm that is not attacked when the moth is common, hence it is to be assumed that they do pass from tree to tree until all are more or less uniformly attacked, but it would appear that their flight to more distant places is more a matter of accident than design.

* My short experience is to the effect that the moths are slow fliers not readily disturbed in daylight and soon settle after being alarmed appearing to fly back to the same tree.—A.M.L.

Mr. Jepson, late Government Entomologist, considered it possible, or even likely, that the decrease in the moth may be due to the increase of natural enemies. Reference is made to this matter subsequently.†

† This is the feature that has puzzled me most; if there are no diseases or parasites present one would expect attacks to increase in severity till all the foliage was destroyed, but a cluster of trees showing evidence of the work of the larvæ on examination may be found quite free of the pest.—A.M.L. So far as I have seen, natural enemies do not account for the final dying out of the pest. There is possibly a fungus or bacterium at work and the migratory instinct may also be the cause.—H.W.S.

SPREAD IN THE GROUP.

It has been mentioned that the moth is confined to the Island of Vitilevu and a few small ones near its coast. The coconut districts of the Fiji Group are the islands of Taveuni, of Vanualevu, of Lomaiviti, and Lau Groups. The shortest distance from Vitilevu to Vanualevu is about 38 miles, and from Vitilevu to Taveuni about 100. The islands of the Lomaiviti and Lau Group are at least 15 miles and 120 miles from Vitilevu.

Coconuts are successfully grown on Ovalau, which is separated from Vitilevu by 11 miles only at the nearest point. It is exceedingly curious that a pest which is so extremely plentiful on Vitilevu should never have become established on these islands, which cannot be regarded as very for distant. And indeed this is the more remarkable when it is remembered that native boats leave Vitilevu at various places and at frequent intervals for other parts of the group, and that a very common package used by natives to contain food and other material is the coconut leaf basket, made by plaiting the leaflets of a section of a coconut leaf.‡

‡ It has now over run Ovalau, Motoriki, and adjoining islands and also Naigani. Jepson reported it erroneously from Vanuabalavu, Mango, and Lakeba.

Thousands of these baskets must be used by the natives and taken to all parts of the group, yet the small leaf moth cannot have been transported by means of them. Some protection against the transfer of the pest by means of the basket is the fact that the native naturally uses a sound leaf and generally uses young leaves which are not so frequently attacked by *Levuana* as the older ones. The process of manufacture of the basket

is such as to cause the detection of any larvæ, which the natives would be likely to remove,* and, further, as the leaf of which the basket is made, dries, it becomes less and less suited for the food of the insect. Pupæ would be less likely to be noticed on the leaflet; they however are rare in this situation except on badly attacked leaflets which would not be suitable for the construction of baskets.

* One fertilised female is all that is necessary to start a fresh centre of infestation.

Of course, it must not be over-looked that *Levuana* may have been introduced into these other islands, or some of them, but has failed to become established owing to the effective work of some beneficial insect or other natural enemy, or some unfavourable condition. The matter must be left at present in this unsatisfactory condition; but all observers are asked, in the absence of any definite evidence, to assume that the reason the pest has not become established on other islands is because it has not been introduced, and on this assumption, observers are asked, should they come across any instance of the insect in any stage being transported from the islands where it now exists, to take whatever steps may be possible to prevent its introduction elsewhere.

CONTROL.

Sprays.—Experiments conducted by the Government Entomologist in 1916, during the Laucala coconut experiments, with poisonous washes showed that there is no difficulty in killing the larvæ while feeding on the leaflets. And with quite young plants, this might be considered a fairly satisfactory method. The poison used was lead arsenite and since the larvæ feed only on the lower surface of the leaflets, the poisonous material when once on the leaves, is not liable to be washed away by rain. With older trees and even with young trees which are commencing to show a stem, the application of a spray involves the use of either a power driven pump or the erection of staging round each palm. With the former, it may be pointed out the waste of material would be enormous,† with the latter, the expense would be too great. It is therefore considered to be impracticable to control this pest artifically by the use of sprays.

† Any spray to be effective must be from below and driven with power. Arsenic and soda would appear to be the best and cheapest spray, say 1 lb of arsenic boiled with a small quantity of soda and used with 400 gallons of water, with a little starch as a sticker and a little whiting for colouring. Lead arsenic used as a spray would no doubt be effective, but is much more costly and the tougher foliage of the coconuts should withstand the harsher but cheaper spray.

Smoking.—In a small island lying not far from Vitilevu, and where the palms are not free from the attacks of this pest, the returns from coconuts are so satisfactory that the place is worked as a coconut estate. The owner regularly collects the fallen leaves, husks, and other vegetable debris and burns them to form dense smoke, and the comparative freedom of the place from serious damage by *Levuana* is set down as due to the effects of the smoke.‡

‡ The island referred to is Nananuira, which with the adjacent island of Nananuicake is situated a few miles north of the port of Ellington. Mr. Soederberg who has resided a great

many years on the second named island states that the *Levuana* moth has never been seen on either his or Mr. Munro's island of Nananuira. The gathering up of the material mentioned should in itself be of considerable benefit. Smoking cannot be expected to destroy massed pupæ, but would probably destroy a few eggs and would probably disperse the moths afield, if any way thorough. Although some of the moths might fall stupefied to the ground, most of them would recover. The experience gained regarding fumigating by Jepson and other entomologists in connection with *Levuana* and by the Malay States' entomologists in connection with the *Brachartona* moth has demonstrated that fact and has led to the abandonment of that method of supressing the moth. Although Mr. Soederberg made this statement, it is possible that *Levuana* was in Nananuira for a period of several years and then died out. As it also said to have died out on the mainland opposite. The smoking cannot therefore be held responsible, as we have previous reports of the appearance and subsequent dying out on the mainland opposite.—H.W.S.

The Government Entomologist tested the effects of smoke on *Levuana* larvæ during the Laucala experiments, using specially constructed torches made with pitch, which gave off a dense smoke, but unless the larvæ were actually scorched by the flames, they appeared to suffer no inconvenience whatever. Of course this is not to be regarded as offering any evidence against the usefulness of smoke regularly on the plantations. For its chief use is likely to be against the *adult moth.* It may be pointed out that "smoke" is regularly used by some bee keepers when attending to the hives to stupefy the bees. With moths in captivity, the introduction of a quantity of smoke into the cage is quickly resented and a large quantity produces stupor. Larvæ are not nearly so susceptible.*

* Smoking bees seldom kills them, they are merely kept quiet while the honey is extracted.

Smoking cannot be regarded as a remedy for the pest, since it would never be made so dense as to kill the moths or even to stupefy them, but it has no doubt a good effect in driving away numbers of them.†

† To drive them away should be the last thing desired.—A.M.L.

Traps.—The use of traps is a matter which has not yet been investigated fully. The use of lights at nights is not likely to be effective as the moth flies by day. During experiments made with a powerful acetylene lamp just over a tray of water and kerosene, this moth was never taken.‡ It is possible, however, that some volatile material might be found to attract them in the same way as certain flies are taken.‖

‡ Lights vary in attractiveness according to their colour, probably some colour would be found attractive to this species. Lubbock in "Ants, Bees and Wasps" has dealt extensively with this question. I have caught butterflies, dragon flies, and other purely day-flying insects at lights.—A.M.L.

‖ Quite possibly some essential oil, mingled with pieces of coconut leaves or fresh copra will be found attractive.—A.M.L.

NATURAL ENEMIES.

Like all other animals, this moth has its natural enemies. A few of them have been noted, but it must be admitted, that at present they cannot be considered to be very efficient. In 1906, the writer found a Hemipterous insect—*Tectocoris lineola*—with its proboscis inserted in the body of a *Levuana* larva, which early in the course of the meal, was killed.¶

¶ The species of *Tectocoris* are plant feeders and *T. lineola* is already a pest on cotton. Several plant bugs are known to attack both insects and plants but no good is to be expected from the species named.—A.M.L.

In 1916, Mr. Jepson, then Government Entomologist, found another Hemipterous insect—*Canthecona cyanocantha*—which feeds upon *Levuana*

SMOKE SCREEN.—Sulphur and tar over dry coconut leaves (near Levuka).

larvæ. In captivity this insect devoured a considerable number of larvæ.* In November, 1916, the Government Entomologist found 12 adults of *Canthecona* on 10 out of 15 coconut palms examined at Nasese. Each one was feeding on *Levuana* larvæ. Three days later 18 adults and 11 half-grown ones were found feeding on the larvæ. It may be remarked that *Levuana* was very plentiful on these palms at the time. †Considerable numbers of *Canthecona* individuals were then released on the palms under observation. At the end of the year, only 12 *Levuana* larvæ were seen and no eggs, cocoons, or moths. Incidentally no *Canthecona* specimens were seen either, as might have been expected from the almost total absence of their food. Mr. Jepson concludes that the diminution of the numbers of *Levuana* was due to the activities of *Canthecona*,‡ and suggests this may explain the variation in the prevalence of the pest as a general rule. It may be remarked, however, that the variations in prevalence are extremely well marked and have been carefully observed on many occasions, whereas the activities of *Canthecona* have been associated with only a single case, the observation being confined to a group of coconuts of quite a limited extent. The insect however uses *Levuana* as food and is certainly a beneficial one. Mr. Jepson also found one of the metallic looking spiders preying on the larvæ of *Levuana*.‖

* Of little importance, they would probably have devoured any insects supplied.—A.M.L.

† Hitherto I have found predaceous bugs very rare in Fiji.—A.M.L.

‡ Not at all likely.—A.M.L. Neither bugs nor spider materially assist in overcoming the wave of *Levuana*. Eggs of C. cyanocantha bugs from Ovalau collected by McNamara were found heavily parasitised.—H.W.S.

‖ The spider is a jumping one of the family *Attidæ*.

It has been stated that the common Hornet (*Polistes hebræus*), is responsible for a reduction in the numbers of this pest, but neither Mr. Jepson nor the writer ever came across evidence of this.¶ The writer in 1918 observed a bird hanging on to a coconut leaflet in Suva and pecking away at something underneath. The bird shifted its position twice during the observation, and each time it swing below the leaf and pecked at the under surface. The palm was found to be badly attacked by *Levuana*, but the circumstances did not permit of the bird being taken. It is fairly certain however that the bird was feeding upon *Levuana* larvæ. It was a brownish-grey bird, smaller than a mynah, and with a fairly long tail.**

¶ McNamara's observations on Ovalau confirm this.

** This description tallies with that of the introduced Madras Bulbul (*Molpastes fuscus*), quite a different bird from the Armenian or Persian bird of that name, it is noted for its insectivorous and fungiferous habits, eating indifferently yellow wasps or hornets, moths, fruit buds, tomatoes, &c.

Judging by the arrangement of short bristles in bunches on the larvæ I believe this to be of a sort distasteful to most birds and only to be eaten by cuckoos and such other birds as habitually eat hairy caterpillars. Some useful facts might be obtained by feeding the larvæ to birds in captivity and much has been done elsewhere in this direction. It may be possible by further observation on the habits of certain insect-eating birds, to attempt their introduction into this island (Vitilevu) from some of the other islands where they have been observed to be very plentiful and busy among the coconut palms; so much so, that in the Lau group, a particular species is referred to as "The Coconut Bird" by the natives.—F. P. Jepson: "Economic Entomology of Fiji," page 39. A very noticeable feature at these two places (Lomaloma and Lakeba) was the great abundance of bird life present, as compared with other parts of Fiji already visited. There was a complete absence of mynahs. Small birds in great variety were noticed to be very plentiful among the coconut palms. Vitilevu does not seem rich in bird life and it would appear that the smaller birds have made room for the rapidly increasing Mynah.—(F. P. Jepson, *idem* page 72.)

FAILURE OF PUPAE TO TURN INTO MOTHS.

After the larvæ are fully fed, they enclose themselves in a creamy white silky cocoon, and pupate. They select for this operation, as has been pointed out, the base of the leafstalk where they are protected by the fibrous material. The number of larvæ on a leaf can be very large, and as they complete their feeding and travel down into the somewhat restricted area referred to, the available space becomes fully occupied and the first arrivals frequently are covered by the cocoons of the later ones. A freshly emerged moth is not an animal best adapted for burrowing through, or past, a mass of closely adhering pupa cases, and undoubtedly many moths are prevented from emerging by the mass of cocoons above their own.* Apart from this however, numbers of pupæ are found to be dead and dry within the cocoons, and so far, the cause has not been ascertained. Small ladybirds, *Anisorcus affinis* (known by the natives as "Baronga") have been seen feeding on the eggs of *Levuana* and several dipterous and hymenopterous parasites have been reared from the pupæ; but they have little effect upon the total—A.M.L.

* A doubtful inference, the lowermost pupæ that perish are probably destroyed by disease, which has a better chance of spreading amongst masses than to single individuals.—A.M.L.

Mites have been found associated with these dead pupæ in some instances and possibly they have been responsible for the death of the insect. It is also possible that some fungus or bacterial disease may be at work.†

† Mites seen by us in material from Levuka were not in sufficient quantities to be of much use, they appear to be scavengers, but may be responsible for carrying a disease from pupæ to pupæ. I have seen mould in several instances in massed cocoons and it is probably a killer. A.M.L.

OBJECT OF THIS PAPER.

The chief object of this paper is to encourage a wider interest in this subject, which must be of considerable importance to anyone owning land which would be suitable for coconut growing were it not for the damage caused by *Levuana iridescens*.

Every individual observer, who has even a single coconut tree of a suitable size to permit of observation being made, is in a position to add to the knowledge on the subject. And as some of the questions to be answered require practically simultaneous observations all over the island, the matter cannot be dealt with by the limited number of officers of the Agricultural Department.

Note.—Those who may report the presence of the moth, are requested to send samples of the insect in its various stages, or a specimen of the affected leaves. Had this been done in half a dozen cases wrongly reported infested within the last few months, much time and anxiety would have been saved.—A.D.

The objects of the extended investigation contemplated may be summarised as below:—

1. To ascertain the distribution of the pest at all months of the year, in the various parts of the island.
2. To determine the relation between the prevalence of the pest and climatic variation.
3. To ascertain whether bad attacks of the pest progress in any particular direction from one district to another, if so, and whether there is any connection between this progression and the prevailing winds.

4. To ascertain the causes of death of the insect as below:—
   (*a*) accidental causes;
      (1) insects;
      (2) spiders;
      (3) birds;
      (4) other animals;
   (*c*) fungus or bacterial parasites;
   (*d*) natural causes (complete destruction of the food supply for example);
5. To investigate methods of control by the use of (*a*) smoking; (*b*) traps; (*c*) other artificial means; (*d*) by the use of natural enemies or diseases.

The Superintendent of Agriculture will be glad to hear from any person interested in the matter. It is particularly desired to obtain information as to the prevalence of the pest on any group of coconut palms (or even a single palm).

C. H. KNOWLES,
28th August 1919. Superintendent of Agriculture.

LITERATURE.

Horne, J., 1881.—*A Year in Fiji, p.* 8.
Knowles, C. H., 1906.—*Annual Report, Council Paper* 23, *p.* 7.
Bethune-Baker, G. T., 1906.—*An. & Mag. Nat. Hist., Ser.* 7, *Vol. XVIII, Nov.*, 1906, *pp.* 343–344.
Knowles, C. H., 1907.—*Annual Report, Council Paper* 13, *p.* 8.
Kirkaldy, G. W., 1908.—*Catalogue of Hemiptera of Fiji, Proc. Lin. Soc., N.S.W., XXXIII, Pt.* 2, *p.* 347.
Knowles, C. H., 1909.—*Annual Report, Council Paper* 27, *pp.* 23 & 24.
Jepson, F. P., 1911.—*Report on Economic Entomology, Council Paper* 25, *pp.* 35–39.
Jepson F. P., 1915.—*Annual Report, Council Paper* 24, *pp.* 20–21.
Knowles, C. H., 1916.—*Report on Laucala Coconut Experiments, Council Paper* 34.
Knowles, C. H., 1916.—*Annual Report, Council Paper* 29, *p.* 13.
Jepson, F. P., 1916.—*Annual Report, Council Paper* 29, *p.* 17.
Jepson, F. P., 1916.—*Annual Report, Council Paper* 29, *p.* 17.
Jepson, F. P., 1917.—*Annual Report, Council Paper* 107, *pp.* 17, 18, 22.
Knowles, C. H., 1917.—*Laucala Coconut Experiments, Council Paper* 84, *pp.* 1–6.
Knowles, C. H., 1918 —*Annual Report, Council Paper* 60, *pp.* 4, 9. 10.
Knowles, C. H., 1919.—*Annual Report, Council Paper* 32, *pp.* 12, 13.

COUNTRY CONVENTION.

The Country Conference or Convention opened in the Council Chambers on the 19th May, 1924.

Mr. A. H. Witherow was Chairman, and had on his right His Excellency the Acting Governor, the Hon. T. E. Fell, C.M.G.; and on his left His Worship the Mayor, Mr. G. F. Grahame.

Among those invited to be present were the following members of the Legislative Council:—The Hon. H. Marks, C.B.E.; the Hon. H. M. Scott, K.C.; the Hon. Alport Barker; the Hon. D. R. Stewart, Acting Colonial Secretary; the Hon. H. W. Harcourt, Acting Treasurer; the Hon. A. Despeissis, Acting Superintendent of Agriculture.

CHAIRMAN'S ADDRESS.

The Chairman said:—

Your Excellency and Gentlemen,—This most important meeting has been called together at the suggestion of a member of the Country Party as they are now known in connection with our Legislature, namely, the Hon. P. W. Faddy, whom we thank. We deeply appreciate the presence of His Excellency, the Mayor, the Acting Colonial Secretary, the Acting Superintendent of Agriculture, and other officers of the Government and the members of the Legislature. I wish to take this opportunity of expressing our thanks to those gentlemen, namely, Messrs. A. Despeissis, H. W. Simmonds, A. M. Lea, C. R. Turbett, F. Simmons, J. P. Tarby, and J. G. C. Campbell, who have so kindly prepared papers and addresses for our enlightenment and benefit. I wish to extend a welcome to members of our own and kindred associations, also to visitors, whom we hope will join our ranks, and assist in the cause which we have as our own, namely, the advancement of all things pertaining to our agricultural, pastoral, and kindred associated industries. Develop them, produce what our islands will grow, and we must become a wealthy community, thus bringing full prosperity to these islands. We felt this a golden opportunity to secure the views of agriculturists, as the presence of the cruiser squadron would ensure the presence of many who perhaps, under other circumstances, may not have been present.

Our main objective, as far as possible, is to gather the collective views of every interest, and if possible to sift out what will be found to the benefit and interest of the Colony as a whole, and the producer in particular. Once arrived at a natural understanding, we wish to put forward our ideas for the consideration of His Excellency and his advisers, in a series of definite proposals or resolutions, as the unaminous desire of members. There are many and difficult matters requiring attention, and I would ask all members to be clear and emphatic in their expression of what they desire, to consider the opposition views, and be reasonable and moderate in the demands that we make. Above all let us work in unanimity and harmony. Following this course, I feel that we must ultimately succeed. A glance at the programme will make you conversant with the large numbers of important subjects which will be brought forward for discussion, and from the numbers present this evening it bids well for the success of the conference. This convention might almost be termed unique in the annals of this Colony, but it is the hope of our association to make it an annual conference, to be held in all probability during the agriculture show week. Before closing my address, I wish to express my appreciation to the gentlemen who have agreed to take the Chair at each day's convention, namely, Messrs. J. P.

Bayly, K. J. Allardyce, J. H. H. Millett, and the Hon. H. M. Scott, K.C.; and an invitation to all members that can do so to be present at the meetings arranged. I will now ask His Excellency to open the conference. (Applause).

OPENING OF CONVENTION.

His Excellency the Acting Governor said:—

Your Worship, Members of the Agricultural and Industrial Convention, and Gentlemen,—I congratulate those who have successfully organised the Agricultural and Industrial Convention, which it is my pleasant task to declare open this evening. Such gatherings cannot be productive of other than benefit to the Colony. At such meetings gentlemen thrash out problems relating to cultivation of economic crops, the establishment of industries and matters affecting the general welfare of the Colony, in full debate, and arrive at considered decisions upon them. It is many speaking with one voice.

During the five years that I have been in the Colony, this is the first active movement towards thorough co-operation throughout the Colony between agricultural interests and industrial interests respectively, a co-operation for which the Government has been consistently desirous. The Government rightly sets the greatest importance on co-operation amongst the various interests of the Colony and with the Government itself. Speaking for the Government, we are always willing and anxious to co-operate on all matters which have in view the benefit of the Colony and which are within the bounds of practical politics. The position was recently set forth by the Governor, Sir Cecil Rodwell, whose words I quote from a speech made on the subject to the Legislative Council. He spoke as follows:—

In conclusion, there is a word I would like to say particularly to the elected members and through them to the European community whom they represent. It is on the subject of unity and co-operation. This is a subject on which it is easy enough to talk platitudes but difficult to offer practical suggestions. Yet there is no doubt that progress has been hampered in the past and is likely to be hampered in the future through conflict of interests and divisions of counsel among the planting and agricultural sections of the population. I do not include the sugar companies because the sugar industry is a thing apart, a very important industry, indeed, to the Colony, but one which is not concerned in the success or failure of other industries so long as its interests do not clash with theirs. I am referring to the copra, banana, rubber, cattle and other agricultural and pastoral industries outside sugar. There cannot be more than five hundred European colonists engaged in these industries, and it would seem that it ought not to be difficult to secure some consensus of opinion among them on matters which concern their interests generally. But the absence hitherto of any central body with authority to speak for planters and settlers collectively, and the consequent necessity of consulting a plurality of bodies or individuals, has been a cause of real embarrassment to the Government. Business would be expedited, and the task of administration facilitated, if the views, requests and proposals of planters and settlers throughout the Colony could be presented to the Government through a recognised association at headquarters having its branches in the various districts. With proper organisation it would come to be recognised that the Government should, as a matter of course, seek the opinion of the association on questions affecting the planters and settlers, and conversely that the association should be the channel for the submission of proposals to the Government whether from individuals or from bodies of planters in the districts. The main point is that the Government should know that any opinion or proposal coming from the association represents the views of planters as a whole, and that weight may be attached thereto; and that time should not be wasted in sifting and examining isolated and independent proposals which represent, perhaps, the views of a small section. The recently instituted Association of Planters seems to afford an excellent basis for an organisation such as I am advocating, but an essential feature would be the establishment of branches in the districts in place of the various local associations which now claim recognition by the Government. The machinery is already there; it only wants fitting together.

That, gentlemen, represented in the opinion of the Governor the ideal body with which the Government would like to co-operate. I am aware that, for a number of reasons that ideal has not fully materialised, but this convention brings it nearer to realisation than any movement hitherto organised

amongst the planting community of the Colony. I can assure you that the fullest consideration will be given to any conclusions you may reach which you may desire to place before the Government.

I should like to say a word regarding the position of the Government. As you know, the slump in the autumn of 1921 necessitated a policy of retrenchment at once being adopted, and in September of that year the question was vigorously tackled by a committee under Mr. McOwan, then Acting Colonial Secretary. It was continued in following years under a strong committee most ably conducted by Mr. Rushton, Colonial Treasurer. It is needless for me to quote figures. A glance at estimates and statements made in the Legislative Council will acquaint gentlemen of the extent to which retrenchment has already been effected. It has reached the pitch when the Retrenchment Committee stated that further economy is impossible without the curtailment of services. I ask you to put yourselves in my place for a few minutes. I know that this policy of retrenchment has affected adversely persons in country districts. We have not been able to spend money on improvements (education, medical services, transport, staff for instance) which we would have liked to have spent. But while this policy may have adversely affected you, it has also created great difficulty for the Government. The lot of a Governor, a Colonial Secretary and a Treasurer who have consistently to carry out such a policy is not a pleasant one. We have to say 'No' more frequently than we would like to many requests which on the face of them are not only legitimate but reasonable. We have sometimes to turn a cold shoulder to what may be hard cases. We have retrenched our staff down to a skeleton and any abnormal circumstances such as sickness or other cause necessitating absence of an officer gives rise to complications not easy to overcome. Yet I know that you may agree with me that, however unpleasant, a policy of retrenchment was the only one possible for the Government during the past three abnormal years, I trust that during your deliberations, you will bear these matters in mind and that, should you find it advisable to make recommendations on subjects affecting the agricultural and industrial interests of the Colony which involve expenditure, you will also consider and make suggestions regarding the method of providing ways and means necessary for them to be carried into effect.

In the life of a Governor or Colonial Secretary problems are almost daily presented covering an endless range of subjects. Questions relating to development, agriculture, finance, staff, native interests, Indian interests, education, medical, racilities of transport, &c., are constantly before us. During the difficult years which have passed we have done our best, with the assistance of the public bodies and inhabitants of the Colony, to keep the wheels running as smoothly as possible with the limited means at our disposal. We will continue to do so. There is, I am happy to state, an improvement in the financial position, although it would be rash to say that we are completely out of the wood. The world is still unsettled, but the prospects at the moment point to a more settled condition which makes it possible for plans of a more definite nature to be framed for the future.

It is my earnest hope that the Loan Committee will eventually be able to put forward proposals, based on principles of sound finance, which would justify the Colony floating a development loan. I trust also that the Treasurer's mission to Canada and our representation at the British Empire Exhibition will result in securing new and assured markets for the produce of the Colony, one main crux of the situation. But in considering loan questions the Colony must be reasonably satisfied that money spent on

development will be sufficiently reproductive to enable the interest and redemption to be met. Once a loan is floated someone has to pay. I sincerely hope that the Loan Committee will be able to put forward schemes which will establish the reproductive nature of a loan thus obviating the possibility of charges of interest and sinking fund becoming a burden on industries already established in the Colony. I have read with interest the agenda of the convention. It is comprehensive and interesting. It contains matter of economic, scientific and political interest, the discussion of which cannot fail to be both instructive and enlightening. I am confident that your deliberations on matters political will tend to strengthen the excellent relationship which has always existed between the European and native communities of the Colony, a condition essential to future satisfactory development, and that you will keep in mind considerations affecting the welfare of other races inhabiting Fiji.

Agriculture is the backbone of the Colony. I am confident that there is a great future for agricultural and pastoral enterprise in the Colony. I assure you again that the Government is willing and anxious to co-operate on all matters affecting the welfare of the Colony and that representations from this Convention will receive every consideration. I must apologise for having spoken at such length, but the occasion is unique. I will now leave you to your discussions which I am sure will tend to the future benefit of the Colony and its inhabitants. Any information which, during discussion, the members of this Convention may wish to obtain from the Government will, I am sure, be readily forthcomong from departments concerned. I have pleasure in declaring the Convention open and I wish it every success.

The Mayor (Cr. G. F. Grahame) said he was glad of the opportunity on behalf of Suva to offer a welcome to the visitors. He would welcome such a co-operation in the Colony. His best sympathies were with the planters, although he could not claim to be a full-blown planter. He fully recognised what the Colony owed to the planters, and that the Colony without them could not progress, and he hoped the conference would be productive of definite results; at least its views must be a factor in helping on the progress of the Colony. He trusted the conference would be very successful.

GRASSES AND PASTURES.

By A. Despeissis, M.R.A.C., Acting Superintendent of Agriculture.

Wherever dairying flourishes as a national industry, there grasses and pastures form a distinctive feature of the vegetation of the country and when the essentials of humidity, warmth, and fertility are combined, ideal conditions are met with, which favour butter production.

These conditions are dominant in essentially dairy countries such as:—Denmark, Ireland, The Channel Islands, in the Northern Hemisphere, Gippsland, South coast and North coast of New South Wales, and a great portion of New Zealand.

In Fiji the same favourable natural conditions are strikingly in evidence, with these additional advantages that there is no off season, that stock graze out all the year round, in an even and temperate climate, where there is no need for rugging and stabling in the winter nor clipping in the summer, where irrigation is superfluous and conservation of fodder in silos or in the hay stacks is unnecessary.

Fiji Pastures.

The fact that high grade butter is made from cows that for general appearance, for milking quality and yield of butter fat, compare favourably with good class dairy cows in other countries, establishes beyond doubt the quality and value of island pastures.

Apart from the indigenous reed grass which covers the slopes on large portions of the open grazing land of the islands, the pastures consist mostly of grasses introduced either by chance or purposely.

That these have adapted themselves to natural conditions is made evident to all who have been up the wide island rivers or on foot or in the saddle, have travelled the numerous bridle tracks that link up the closely dotted native settlements.

These pastures are seen along the river flats, once thickly clothed with trees; they are seen penetrating valley land through which run the feeders to the main rivers, and here and there also in patches over the easier slopes adjacent.

" Plenty of grass " is how the stockman sums up in a few words the result of his observation. In its wider sense this may apply to good and palatable grasses as well as to poor and harsh grasses, but as if generally found, good land grows better grasses than bad land, it so happens that in Fiji where the land is rich, the pastures are good, nutritious, and are well stocked with such good kind of grasses and herbage as are mentioned in this paper.

Para Grass.

Para grass is at present the most widely distributed pasture grass in Fiji and the most striking for its growth and its carrying capacity, wherever it has established itself on the windward or the moister side of the islands. Its aliases are numerous: known also as Mauritius grass, it came to Australia some years ago under the name of " African Wonder Grass " and was then known as *Panicum spectabile* then *P. muticum*, also *P. molle*, and more recently as *P. barbinode*. It grows best on moist low lying places and on river banks which it binds against erosion at flood time.

All stock eat it greedily but as it lies thickly matted on the moist ground, they trample down and waste as much as they eat.

For that reason small paddocks and frequent changes, providing a spell, are beneficial. Its carrying capacity on Fijian soil in the wet zone is often discredited by those who have not had ocular evidence, but two beasts to three acres is not uncommon.

In the cane-fields on the Rewa it makes clean cultivation costly as it throws out streamers which root at the joints from which straight shoots spring up. In the dry zone on the other hand, its growth is not so luxuriant except on bila land which is periodically flooded. As a smotherer of weeds, it is often seen standing up three to four feet high, supressing even shrubs.

At Tailevu on the Soldiers and Sailors Dairy Settlement it has proved itself a first class milk and butter fat producer. Yet where stock subsist almost exclusively on Para grass a suspicion exists that as a fodder plant, in certain areas, it is somewhat deficient as is indicated by the prevalence of osteoporosis, a form of malnutrition which manifests itself in the bulging of the facial bones of young horses. A change of pastures or a mixed diet counteracts that tendency that is more in evidence in stock of thoroughbred strain.

Para grass seldom seeds in higher latitudes, but here at the present moment, about Easter time, it is seeding well. It is easily propagated by

ploughing the ground and dropping a cutting at intervals of a yard or so every other third or fourth furrow, the field being subsequently smoothed over by a harrow.

Guinea Grass.

Is another prominent member of the family of grass plants numbering hundreds of species, mostly tropical. Its botanical name *Panicum maximum* suggests size. Under favourable conditions it grows to a man's height, forming tussocky perennial clumps which go on expanding. These when grubbed out, can be pulled into scores of plants, as it is the general practice to propagate by root division, seeds being not always procurable. In any case they are sown like sorghum on prepared land before the end of the wet season, at distances of 2 feet by 3 feet, and at a depth of ½ inch below the surface.

Unlike Para grass which thrives on low wet land, Guinea grass does better on moist but well drained slopes or along ditches on the road side. It prefers a friable soil to a heavy land and thrives best in the drier portions of the islands.

Where stock graze over the land, Guinea grass is seen in tussocky clumps the fresh growth being eaten first. The heaviest return as with Para is obtained when it is cut, every six weeks or so and fed to stock, being then tender and succulent and eaten more greedily. In feeding value it com pares with the best of grasses being rich in muscle formers and fat producers.

In Guadeloupe and Jamaica it is the principal fodder grass up to several thousand feet elevation and succeeds on poor clay and on the coast sand. It is advisable to guard against over feeding solely with this grass.

Paspalum dilatatum.

Has been introduced on a number of farms in Fiji, but I have not yet seen here as good paddocks of the grass as I have seen in New South Wales and in Western Australia.

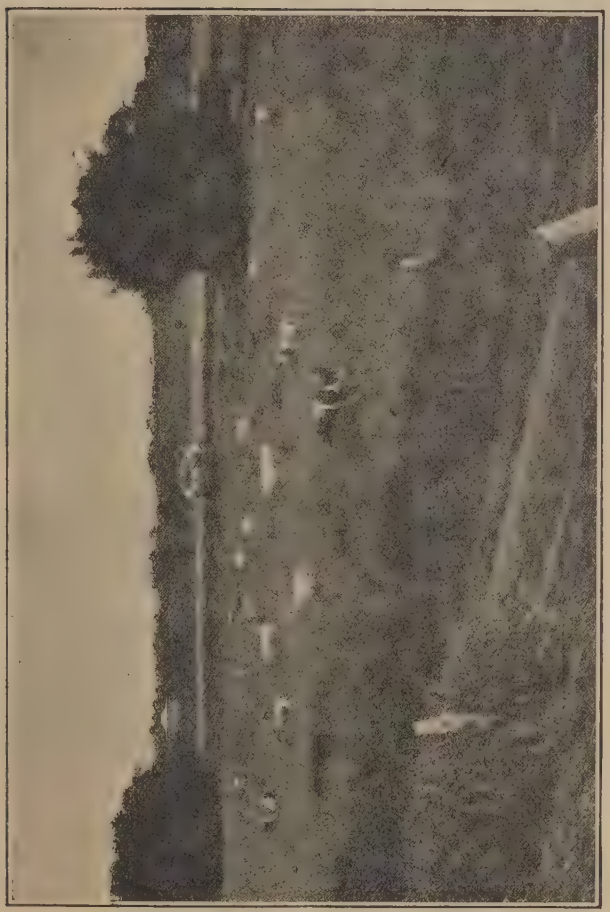
Inquiries made from the Queensland Government Botanist also indicate that it does not thrive there under definitely tropical conditions. This is evidenced on the low lying country in North Queensland, where it makes a poor growth, whereas on the tableland on the Atherton Downs, only a few miles away from the coast as the crow flies but at an altitude of 2,000 feet, in a cooler climate it thrives admirably.

The inference is that in Fiji, although doing well enough on the low levels, it is likely to do better at higher elevations of 1,000 to 1,500 feet. This point is worth noting and I shall be glad to have the experience of graziers as it applies to these islands.

The seeds sprout best when hand shaken, steamed between hot blankets and rolled after sowing on prepared land, where they may lie a long time before germinating. Six to ten pounds of these seeds are required per acre. Rolling causing moisture to ascend helps sprouting. It will grow even on somewhat sour soils where other grasses will not grow; good pastures will be produced within twelve months. Paspalum is not liked by stock if allowed to grow up into flower stalk. After a few years, a Paspalum pasture will become overcrowded, root bound, and will deteriorate. It should then be broken up, harrowed and allowed to revert to a Paspalum field if desired.

Paspalum distichum.

Another grass of the same family known as " Giant Water Couch " is much liked by stock. The growth is most luxuriant, but when established



DAIRY HERD, TAILE'U.

along drains it chokes the flow of water and in orchards it smothers trees. On cultivated fields it also becomes a plant out of place and proves a weed difficult to eradicate. In other respects this water Paspalum is a very useful grazing grass in wet land, it spreads rapidly and is readily propagated either by seed or cuttings.

Another useful Paspalum is the " Carpet Grass " a low creeping kind that sets closely to the ground and makes a good lawn grass that will stand heavy stocking and is very palatable. It is the *P. compressum* seen on several places about Vitilevu either on cultivated or on grazing lands where it should be a good grass for sheep but is rather too short for cattle. The Government Veterinary Officer, Mr. Turbet reports that it is widely distributed in the Bua province.

Of other Paspalums, I noticed in Fiji three that have little or nothing to recommend them, viz., *P. conjugatum* and *P. orbiculare* which grow on roadsides, waste places, and moist grass land and are apparently passed over by stock. The former is known as " Thurston Grass " on the Suva side of this island and also on parts of Vanualevu. It is reported on the whole group and has acquired a poor reputation for grazing, except at Tailevu where good results have been recorded, particularly on small plots that have been top-dressed with a phosphatic fertiliser. It does not do well on dry hill side. In Ceylon it is known as the " Barbados Sour Grass " and in the Philippines as " Bitter or Buffalo Grass."

The third undesirable kind, *P. virgatum*, tall, erect, coarse, and tussocky grows much stronger than *P. dilatatum*, but is disliked by stock, and has the tendency to smother out the better kinds of grass and for that reason should be suppressed.

Panicum distachium.

Is well distributed on the lee side of the island from Nadi to Tavua under the name of " Thurston Grass," and is said to have been introduced from Ceylon. Not a long lived grass, and fairly common on fallowed land, it produces a good deal of palatable, nutritious feed. The Government Veterinary Officer reports in favourable terms on that grass which is known as " Panicum " in Lautoka, Nadi, and Ba and according to Mr. C. H. Wright, late Government Chemist and Mr. Veitch, Entomologist of the Colonial Sugar Refining Company, at Lautoka, this grass is probably the one introduced by Sir J. B. Thurston. This, in the opinion of Mr. Turbet, is probably correct, as being a good fodder, it was more likely to have been brought here for that purpose than that other grass, the widely distributed *Paspalum conjugatum* of disputable value and often referred to under that name.

Chloris guyana.

Rhodes Grass (*Chloris guyana*) one of the " windmill " grasses, a native of Africa, perennial in its growth and producing strong creeping runners or stolons which strike roots at the joints. Time should be given to these to become firmly established before turning the stock on Rhodes Grass, or they will pull the runners out of the ground, leaving space for weeds to encroach on the grass. It is liked by stock and is considered in Transvaal an excellent dry hay grass. Three to five pounds of seeds mixed with ashes or bonedust will sow an acre. On light soil or hilly country inclined to become dry, it is preferable to Paspalum.

Kikuyu.

Was unknown in Australia five years ago, and is therefore still in the experimental stage. It is much liked by stock, and although it has many

excellent points as a pasture grass that will accommodate itself under the most varied conditions it should better be left out of cultivated land. Fortunately, unlike Johnson Grass, whose introduction on some of the best land in Fiji is now recognised to have been unfortunate, Kikuyu (*Pennisetum clandestinum*) does not seed or only seeds very imperfectly, except in its native home among the Kikuyu native tribe in British East Africa. For that reason it is propagated from cuttings dropped in shallow furrows about a yard apart. It is a perennial grass with vigorous runners both above and below the ground. Although doing best on good land it has proved a strong grower on poor or dry hilly country, also for binding sandy banks, or for smothering such weeds as bracken, blackberry. Experiments in that direction would be worth trying here on land over-run with Koester's curse (*Clidemia hirta*) and with nut grass.

Tricholæna teneriffæ var *rosea*, Natal Red Top. Is an annual slender grass, with a purple tawny panicle. Introduced many years ago by Mr. R. L. Holmes, and sowed on the western end of Vanualevu, it comes up with the first rain, stock eat it best when it is tender. Unfortunately it does not last long after May, in the dry zone and readily carries bush fire towards the end of the dry season. Mr. L. N. Anderson of Delanasau says it thrives even in poor soil, does no harm to coconuts and makes luxuriant growth in rich pockets. It does well on loose or sandy soil at medium altitudes in the drier regions, and is favourably reported on from Hawaii and Queensland. Where white clover does not succeed, it may with advantage be grown in conjunction with paspalum.

Crowfoot or Goose Grass (*Eleusine indica*) is another grass that is spread over Fiji where says Mr. Turbet it is well liked by horses but cattle do not touch it. It is a annual dwarf, prostrate, open pasture grass, well spoken of by sheep owners in North Australia, being nutritious and growing well in rich soils in the hotter drier parts of the State. In the cultivated fields of South Carolina it is commonly used for hay.

Other useful grasses occur in Fiji which being as yet sparsely spread will only be mentioned, viz.: Bermuda Grass (*Cynodon dactylon*), Buffalo Couch (*Stenotaphrum americanum*), Yellow Foxtail (*Setaria glauca*), Mission Grass (*Pennisetum setosum*), Barn Yard Grass (*Panicum crus-galli*).

Others again occur but most of them are either of minor importance or have not yet been widely distributed. Steps have been taken to introduce under guarantees of purity of seed and freedom from pests some desirable grasses, but there is no need at present to anticipate future actions.

Leguminous Fodder.

Although in Fiji the soil is rich and the climate mild and humid and favour vegetation, the need of leguminous crops is readily recognised for improving the soil and supplying forage for the live-stock. Legumes will grow on nearly any land that is well drained, particularly under the stimulating influence of phosphates and that of lime. On account of the large amount of protein that they contain, the legumes have a high feeding value. Nearly all class of stock relish the forage which is nutritious, palatable, and readily digested, and the grain is excellent as a concentrated feed.

The leguminous family is richly represented in Fiji amongst trees and shrubs and herbs. Of these, as forage plants, *Desmodiums* are widely distributed. It is the Fiji trefoil, greatly valued as fodder, closely allied to the "Florida Beggar Weed" and the creeping "tick trefoil" which are equally prized in other tropical regions. A slender, creeping perennial herb, growing in open grassy spots. Widespread through the main islands of the group. It is a good soil binder and stock eat it readily.

This small trailing plant somewhat resembles the clover and produces small flowers. It thrives well with Bermuda and other mixed grasses and grows quite thickly in some areas. When supported, its growth is more upright. After grazing or cutting, the stems bud afresh and the plant resows itself by means of fallen seeds or seeds carried by animals.

Several other leguminous creepers occur in Fijian pasture land but as these have not yet been identified I will refrain from referring to them more at length, except in saying that with proper management their growth could be encouraged and extended.

To grow Lucerne with profit in Fiji is one of those problems that has always baffled the attempts of those bent on conducting experiments. The failure so far cannot be put down to one single reason or other, but rather to a combination of causes that operate adversely. The physiography of the country and other favourable conditions combine to suit the requirements of lucerne which in every case must be planted on land as nearly weed free as possible. It is unfortunate that on the whole lucerne has not been found suited to the tropics, although with irrigation under less humid atmospheric conditions, it has been grown with moderate success in Ceylon and also in Hawaii where various methods of planting have been tried, the one most suitable to local conditions of climate and weed growth being in widely spaced drills, where irrigation alternates with horse hoeing. It is easy to understand that under such conditions, the cost may be out of proportion to the value of the crop. Lucerne is a lime loving plant and the acidic soils of Fiji are often poor in that constituent.

Desirable leguminous fodder plants have been introduced, one of the most promising being Subterranean Clover others will also be tried such as Kudzu (*Pueraria thumbergiana*), a vigorous perennial Japanese creeper, with an edible starchy root. Both are likely to prove practical legumes for planting on the hillsides and poorer soils. Besides these, Strawberry Clover, particularly that variety called Shearman's Clover, and Bird's Foot Trefoil, which are likely to take a hold and spread, will also be tried.

No account of Fiji pastures would be complete without reference to the sensitive plant *Mimosa pudica* which is spread wherever cattle are found. It possesses the one very serious disadvantage of being prickly and rough on barefooted Fijians and Indians, and even on stock unless it is kept in order by feeding down and an occasional burning. Its redeeming features are its hardiness, great feeding value, producing firm meat and increased flow of milk. On coconut plantations it also increases the nitrogenous content of the soil and incidentally the copra yield.

Pasture Management.

The establishment and improvement of pasture land is often slow and gradual, and depends on the prominence given to the plough and to the phosphate distributor in farming practice.

From the foregoing, these facts stand out:—

That however good and well adapted to local conditions a grass or a fodder plant is, no one kind alone fills the bill on a dairy or a grazing farm and a mixed diet is essential to the contentment and the satisfactory working of the animal machine, when directed to manufacture marketable products such as butter fat, meat, or wool.

Feed value, digestibility, palatability, and seasonal supplies are factors that keep that living factory at work night and day without interruption.

The mere sowing of seeds is not all that is necessary to provide a mixed diet and fresh feed. It is just as essential, once the pasture has been established, to maintain and to improve it.

Small Paddocks.

Are an obvious necessity; they make stock easier to handle and more tractable; they also enable a spell being given to the pastures, whenever required and facilitate the withdrawal of stock when the ground is soft and becomes waterlogged or when grasses are seeding and require protecting. They will not only save the extinction of the finer grasses but they freshen the feed and they enable the grading or the segregation of stock, minimising infection whenever necessary.

Top Dressing.

Next to small paddocks is an important matter. Continuous grazing without fertilisation causes a decline in the carrying capacity of pastures. On the other hand, a top dressing, say, of lime and of phosphate not only increases that carrying capacity, but although no actual quantity of nitrogen is added in the shape of manure, yet chemical analysis and the graziers own ocular evidence as well also as the natural perspicacity of the stock, show the striking improvement of the top dressed grass as compared with the pasture not top dressed. In fact the practice has been proved to be so remunerative in England and on the Continent that it has become national in its application.

The reason why lime in conjunction with phosphates improve pastures and more particularly poor or worn out pastures is due to—

(1) the very rapid increase in leguminous herbage;
(2) a rapid improvement in the quality of the surface soil;
(3) The accumulation of atmospheric nitrogen fixed by the organisms attached to the roots of the clovers and trefoils through this increase in nitrogen, the grasses being provided with the conditions which enable them to flourish.

Of phosphate, the choice rests with bone dust, with basic slag or Thomas' phosphate or with superphosphate.

The grazier in Fiji will have to ascertain, whatever he buys, that the cost per unit, that is the cost of each one per cent. of phosphoric acid per ton of phosphate, landed, is proportional with the cost of the fertiliser and also whether, buying superphosphate of the 22 per cent. concentrated grade is not more advantageous than buying the 14 per cent. Thomas' phosphate. When costly sea freights and haulage have to be added to the initial price at the works, the more concentrated though more costly fertiliser often proves the cheaper when delivered at the ground.

In Fiji at all events, the money value of a top dressing of potassic fertiliser is not apparent. The analysis of numerous samples of Fijian soil by Mr. C. H. Wright show no deficiency but rather a good supply of potash. Laboratory investigations in that direction harmonise with unmistakable indications afforded by nature of the presence in the soil of a good store of that element and shown by the vigorous growth of such potash loving plants as numerous solanaceæ:—tobacco, bringels, chillies, wild solanums, also of pineapples, of bananas, and of coconuts.

Weeds.

Whether present in abundance or conspicuous for their absence, are the first indication to the casual observer, that pastures are either neglected or are well kept.

Nothing detracts more from the value of a farm than the presence of weeds in quantity. They lower the stock carrying capacity, increase working cost and reduce crops and returns. They also reduce the value and the equity of the farm and that margin between actual cost and that fluctuating

amount the holding might realise if sold to advantage. Weeds are often introduced through carelessness. I saw a few weeks ago a bundle of dock heads taken from the packing used in a case containing breakable goods. That case contained enough dock seed to infect the whole island and yet it had gone through the Customs barrier with no suspicion attached and no indication that the material used for packing was prohibited by regulations. Neglected weeds will cause weeks, months, and even years work to get rid of. "One year's seeding seven years weeding," an old saying and true.

Fortunately the introduction of noxious plants is now surrounded by greater obstacles than used to be the case. The Department of Agriculture has at last on its technical staff a trained Botanist and Mycologist through whose hands all seeds after fumigation go and no package is released until a search has been made for seeds of weeds and noxious plants. All earth and packing material is destroyed.

Further than that, and before seeds or plants are allowed to land, a "permit" must have been applied for and issue by the Department of Agriculture and for that certain conditions must be complied with.

Through neglect on the part of importers or their agents to comply with these conditions, packages of useful grass seeds are now and again after landing, hurled into the furnace and destroyed. There is no option on this matter and it is desired that everyone should know what the conditions are, that regulate the introduction of seeds or plants.

Burning off.—Useful in some cases may become an injurious practice in others. On weedy pastures, where grass seeds, burrs, thistles abound, it is helpful in destroying seeds or preventing seeding, otherwise it is often injurious; destroying the finer grasses and reducing the humus and organic matter which have accumulated on the surface.

Overstocking and Understocking.—Overstocking should be resisted to the utmost, for it leads to the early destruction of the more palatable and nutritious feed, to the fouling of the ground; the spread of parasites and of germs of diseases.

Understocking on the other hand leads to the crowding out of the finer and less aggressive grasses, the low growing clovers and trefoils lying dormant on the ground and to weeds being allowed to seed. It is therefore easy to understand how important judicious stocking is, in maintaining pastures clean, well balanced and in good heart.

One of the most common causes of weedy pastures, is the lack of preparation or the incomplete preparation of the land. New land just cleared does not require half the careful preparation that old cultivated fields, overrun with weeds require. It is only by thorough and prolonged cultivation, with periods of rest between, sufficient to cause the germination of seed weeds brought up close to the surface, that such fields can be rid of many of their weeds.

Another important essential consists in sowing the new seeds at the proper season so as to make sure of a good strike, before they become smothered by weeds.

Other Pests.

A few concluding remarks while discussing the Management of Pastures, will emphasise the fact that, in many respects, Fiji can at present boast of its "clean pastures." Here the tall herbage does not serve as a jumping off platform for the larvæ of ticks waiting for some cattle host to turn up; nor is the ground infested with germs of diseases buried with dead beasts whose blood was alive with most virulent organisms such as anthrax, black leg, foot and mouth disease, and other decimating epizootic diseases.

POLLED ANGUS HERD, REWA.

One word of caution is not out of place. It is difficult in Fiji to move promptly from island to island, or even from place to place on the same island. It is therefore always advisable in case of an obscure and sudden epizootic disease breaking out amongst stock, that together with the intimation that something is radically wrong, the Government Veterinary Officer should also receive, if possible, blood smears for miscroscopic investigation. A short paper giving directions to that effect is published by Mr. Turbet.

As a further precaution, until the matter has been satisfactorily determined, is to regard with suspicion any unaccountable death of stock, when preceeded by symptoms showing distress and rapidity in the march of the disease. In such cases, the burning of the carcass is preferable to burying, sometimes at a shallow depth. This will prevent soil contamination by long lived, virulent germs, which periodically are brought up to the surface by earth worms and are picked up on grass by stock grazing on the infected land.

One line of investigation suggests itself to me, which after conferring with Dr. Lambert, I am encouraged in following up. It is recognised that the greatest trouble with grazing stock, of all kinds in Fiji, is that caused by internal parasites.

Like the human, stock in the tropics have their own kind of hook worm; they also pick up with grass, eggs or larvæ of their tapeworms, their flukeworms, their roundworms, their whipworms, their pinkworms, and others, which cause loss of condition and a degree of unthriftiness.

Several drugs are used for these parasites; some chemical, such as carbon bisulphide capsules, copper sulphate, carbon tetrachloride used by the Rockefeller Institute in their hookworm campaign, others vegetable, like chenopodium. In many cases the proper administration of these particular drugs show 90 to 100 per cent. efficacy. Oil of chenopodium is an extract from a tropical herb, of which the common Goose-foot is an example. It includes a few species interesting for their utility.

In Australia, wherever overstocking has not exterminated allied plants like the Blue Bushes and Salt Bushes, valued for their nutritious quality and their anthelmintic properties, internal parasites do not seriously affect station bred stock. The "Mexican Spinach" considered a wonderful sheep fodder is a variety of chenopodium. Most of the plants of that family are much liked by stock, as an evidence of the fact, they are seldom found in paddocks where stock run but are common in gardens and places which are protected.

The value of chenopodium of wormseed, Dr. Lambert informs me, was accidentally traced in Louisiana where those negroes who use the leaves for spinach and practice the habit of chewing the seeds, were found comparitively free from hookworm and other parasites, whereas others who did not have the opportunity of eating the wormseed showed heavy infestation.

Stock are starved in more ways than one, the more common being by shortage of food but often also owing to the fact that much of the food they consume goes to sustain internal parasites.

It follows therefore that, if by introducing some of the chenopodium herbs, and particularly the officinal variety, which though a weed is not a pest, we can grow side by side lush feed and worm poison, it will go a long way in keeping on farm stock that attractive bloom that goes to making first quality meat or profitable butter cows.

CATTLE IN FIJI.

By J. P. Bayly.

Almost every planter and farmer in Fiji dabbles in cattle. In most cases perhaps just as a side issue, either in a large or a small measure. But there have been several definite attempts to make cattle the main objective and practically the single purpose of the estate. In the case of the former, profit or loss was not perhaps worried much over by the owner, but when cattle have been the main string, success or failure of course meant everything. And I make bold to state that the failures outnumber the successes. This is probably true, even if we include those who raise cattle merely as a side line, and I certainly think it cannot be doubted where attempts have been made to go in mainly for cattle. Now, it is well, I think, for us to attempt to delve beneath the surface, and look for the causes which have mitigated against the success of cattle enterprises.

The main cause which we seem to hit against is the large losses in cattle "going bush," which occur. These cattle rapidly get wild, and can be got only in one way, that is with the rifle. They may appear as so many head in the book muster of the estate, but in the actual muster they are never never there, and except for the value of their hides they are commercially worthless. Now, what are the reasons which permit of cattle "going bush" so quickly here? They are (1) lack of fencing and paddocks, (2) lack of handling or what is worse, attempts to handle them by inexperienced men, (3) the bad nature of the country, from a horseman's point of view, that the cattle can get into and from which it is practically impossible to dislodge them. The first difficulty can be easily got over—have more paddocks. The second looks just as easy to overcome, though there has been in the past, and there is at present, a growing tendency to think that any man can run a cattle estate. The third obstacle is always with us and we simply have to work accordingly. In the principal cattle countries of the world, such as Queensland, there are great open stretches of plain and open downs—country clear to the horizon—and on this sort of country good men on good horses can handle the wildest cattle that ever bellowed, and on this sort of country, too, a cattle enterprise can be run with practically no fencing. But contrast this with conditions in Fiji. Plains and downs are a rarity, if they exist at all. My own holding embraces about 15,000 acres, and I don't think there is a continuous flat of, say, even 100 acres, in the whole of it. In addition even in the open country, which we have round the dry side, there are numerous patches of thick scrub, so thick that it is a difficult matter to shift cattle from them, even with dogs.

These are the main difficulties as I see them and once they are recognised the first step to overcome them is taken. People come here with set ideas, brought from other countries, on how certain work should be done, and in a good many cases doubtless they are right, but I venture to state that in cattle breeding in Fiji a different set of conditions are present, and work has to be modified to meet them. This tendency seems to show out even in the issuing of grazing leases by the Government. I understand that our present leases are modelled on an African Colony's plan, where conditions are doubtless entirely different to conditions here. Where a country has thousands of acres of plain country, with natural grasses, it is clear that all the capital expenditure needed for a cattle ranch is a minimum in homestead buildings and a few homestead horse paddocks, and in such cases a long term lease is not vitally necessary. But where conditions are just the opposite, as they are here, capital expenditure on a most expensive scale is

needed. Expensive fencing has to be erected and maintained, and imported nutritious grasses have to be laid down for we have no good indigenous grasses. In fine then, a man starting cattle in Fiji has to, in addition to the ordinary homestead buildings, yards and paddocks, go in for a complete system of fenced paddocks, and the planting of good grasses. The present term of grazing leases is 21 years, with an option for a further term, but options are never satisfactory, especially to a bank. And I agree that 21 years is too short, in view of the heavy capital expenditure that faces any cattle enterprise here. I should like to see a resolution passed at this convention asking Government to make grazing leases agree with the present agricultural leases as to the term and the re-assessment periods. In these agricultural leases the term is 99 years, with re-assessment every 33 years, and this tenure would let a cattle man have a sense of security, and build a permanent home with full confidence.

Before concluding, I will say just a few words as to the marketing. Colonel Rainey told us, some years back, that the cattle industry was in a vicious circle, and that while we have too many for local consumption, we had not enough to warrant an export business. The Government, to end this state of things, some years back, gave a very advantageous lease of the land now known as Tova Estate, with a condition of the lease that a cannery had to be built within the first six years of the term. This six years is nearly up now, and the Hon. Henry Marks, the present lessee, has assured me that before very long a cannery will be erected and working on his Tova Estate. With this cannery in operation all troubles as to marketing of cattle should be at an end.

BREEDING DAIRY CATTLE.

By E. F. Simmons.

Paper read at Agricultural and Industrial Convention on 22nd May, 1924:

From the dim ages the dairy cow has been wrapped up in the human race, and it is a very true saying "that the human race cannot exist without the cow." Dr. E. V. McCollum, of the John Hopkin's University, has made a most remarkable discovery, probably the most important contribution of the world's knowledge of foods made during the last 100 years. This discovery is that milk contains one of the two groups of elements absolutely essential to the maintenance and growth of human life. With this knowledge as to the value of milk, as a food, it becomes all those who are interested in the dairying industry, or I should say interested in the dairy cow, to keep only those animals which they know have a strong and robust constitution. Which are the most profitable dairy cattle to keep? is the question often asked. The most profitable dairy cow is the cow of any breed correctly selected for type, conformation and production. It is much easier to select to-day than a few years ago for production, on account of the Babcock tester, and milk scales, so the intending purchaser can ask the seller what the dam, sire's dam and so on have produced, but he must study and learn what he must look for as regards type and conformation. The general points of all dairying breeds are somewhat similar, and a general outline of the various points applies equally to all breeds. The dairy cow is a machine, and she has been developed along lines quite the opposite from the beef animal. In no farm animal does type or individuality affect profits more than in the dairy cow. A dairy cow is like a bank, there is the paying in department, and the paying out department. One department cannot carry on without the other.

Every scale of points starts with the head and I consider in the muzzle of a cow is the first indication of a producer. The big muzzle and strong lower jaw is an indication of a worker. With this she can consume, and masticate the great quantities of food necessary for a large production. The head should be lean, broad of muzzle, large nostrils, moderately short and broad of nose, with some dish to the face. Prominent, clear, calm eyes, wide apart beneath a full forehead. The cheeks should be deep and the lower jaw strong. Fine, medium sized, thin and well-placed pointed ears, covered with fine hair on the outside, and long hair at tops and edges. If there are horns they should show quality, not being coarse or shelly. The poll should be covered with a thick layer of fine long hair. A good sign is the yellow colour of the inner skin of the ear; this is considered an indication of a rich butter fat cow. The neck tends to be long and muscular. With bulls it should be heavy and strong, and usually possesses a prominent arch. The lower part of the neck should have a thin dewlap. The neck should have a neat attachment to the head, though not so neatly as in the beef breed. The shoulders should incline at a good angle, well into the back, fairly close together, and forming with the back line rather refined, narrow, or sharp withers. The brisket is narrow, and not carried forward. The chest must be of ample depth, and a fair spring of rib. The ribs should have a fair arch from the back, showing ample chest room below, and the front flanks should be well filled out, showing good constitution in the chest capacity.

The front legs should be straight from side or front. Beware of knees being close together, which indicates narrow chest, and poor constitution. The back should be strong, straight and well sustained with little depression. The back bone should be large with open vertebræ. The barrel long, well rounded, with large abdomen, strongly and timely held up. Loins and hips should be broad, fairly level between hook bones. Hook bones fairly prominent. Rump, long, broad, high, carried out straight to dropping of tail. There should be plenty of space between the pin bones, as a cramped space here tenders to difficult calving. Quarters, deep, broad, straight behind, wide, and full at sides. Flanks deep and full. Legs comparatively short, clean and nearly straight, wide apart, and squarely set under the body. The tail large at base, setting well back, tapering finely to switch, and reaching to hock or below, switch full.

Hair and handling.—Hair healthy in appearance, fine, soft, and furry. Skin medium thick, and loose, mellow to touch, the secretions oily, plentiful and of a rich yellow or brown colour.

Mammary or milk veins.—Very large, and tortuous extending along the belly until they enter the milk wells. Always look for a well-veined cow, as these veins generally indicate the animal's capacity to produce milk.

Udder.—Very capacious, very flexible, quarters even and nearly filling the space in the rear below the twist, extending well forward in the front, well held up and attached. Teats well formed wide apart, plumb, and of convenient size.

Escutcheon, also known as the milk mirror, is found back of the thighs or between them. The Frenchman, Gueuon, argued that the escutcheon indocated the capacity of a cow to produce milk; modern dairy cattle authorities attach no special significance to the escutcheon, Guenon's theories not having been born out in facts.

These, gentlemen, are the main points of dairy cattle. Perhaps to the laymen they are confusing and in the selecting of diary cattle could be condensed into the following:—Look for strong lower jaw, large muzzle, good heart girth, long barrel, to be in keeping with the animal, large but not

fleshy udder, and well attached, milk veins well pronounced, and carried forward to large milk wells and plenty of room between pin bones. In the male, milk veins should be pronounced and large, well placed large rudimentary teats, scortum well attached at the rear, and space between hind legs well split up.

In selecting animals two things are to be considered. The individual excellences of the animal, and its ancestry, or breeding. Select pure-bred animals, or high grades of a breed conforming as nearly as possible to the ideal type. Do not try to remodel a breed. Do not confuse the terms breed and type. The term breed is never used except in referring to pure-bred animals, while it is correct to use the term type in speaking of grade or crossbred animals. Do not dispose of your old bull until you find out how his daughters turn out as milkers. Try and effect an exchange of bulls with your neighbour until his daughters are proved. Too many good bulls are lost through haste. Choose deliberately, it is economy to take plenty of time in dealing, study your conditions, and select animals accordingly, and make it a permanent policy. Be sure and select animals of strong constitutional vigor. Breed with a definite aim. In selecting a future herd sire, remember the bull is 50 per cent. of your future herd. Do not attach too much importance to pedigrees, and too little to individual excellence. Avoid inbreeding, leave it to the master spirit of the breeder's art. The question is often asked, which is the best dairy cow to keep. This depends on your local conditions. All breeds are good. The pure bred industry has taken hundreds of years to build up and families have been established who have made each breed famous.

The origin of the Jersey breed is unknown, but most probably they are descended from the old Brittany and Normandy cattle, which breed they resemble in colour. The purity of the Jersey breed has been preserved since 1763, when an Act was passed prohibiting the importation of cattle into the island of Jersey unless for killing.

The Ayrshire's native home is Ayrshire in Scotland. The origin of the breed is also a complexed one, and the earliest authority (Aiton) in 1811, says:—"The breed is the native breed of Ayr, improved by certain other stock." In 1770 John Dunlop, of Dunlop, imported cows from Holland, or Teeswater, and crossed them with the Ayrshire. Other writers claim that the Channel Island cattle were crossed in. In the early days Ayrshires were black and white in colour.

Of the Shorthorn, they originated in the north-eastern part of England. Their history is veiled in obscurity. No doubt cattle brought in by the early invaders of England were crossed with the native cattle. About 1700 Michael Dobinson and Sir William St. Quinton brought bulls over from Holland and used these in their herds. In 1789 George Culley wrote:—"Mr. Michael Dobinson's imported bulls did much service in improving the breed, and Mr. Dobinson, and neighbours even in my days, were noted for having the best Shorthorn cattle." The Shorthorn, although a beef beast, has by careful selection, proved herself a wonderful dairy cow.

The Friesian cattle is obscure. In Holland they have been kept for over 1,000 years, and it is assumed that these cattle are descended from the prehistoric Giant Ox. From very early Dutch writers they are referred to as being large, more or less white in colour, and great milk producers. In studying the history of the different breeds it is quite evident that the Friesian blood has been introduced into several to the benefit of each breed.

Of the other dairy breeds are the Guernsey, also of the Channel Islands, and probably of the same origin as the Jerseys.

The Dexter Kerry are a small type of cattle whose native home is in the western island among the Kerry mountains.

The Red Polls are generally placed in the dual-purpose type, also in the same class are the Devon and the Brown Swiss. The Red Polls have during the last few years produced some heavy milkers, and I remember during a recent visit to America seeing at Duluth a Red Poll cow that had produced 22,000 lb of milk.

One of the causes of failure with Fiji cows is the Indian method of allowing a cow to suckle her calf. I have found it a heart-breaking job trying to keep a real good cow milking for any time. Be sure and milk your heifers with their first calf a full nine months, teach them milking is their life's work. In the state of Washington, in America, there is a very large barn facing the railway which says that this is the "Home of contented cows." Gentlemen, your cows must be contented or else your dairying will not be a success. The "home of contented cows" is also the home of Segis Pietertje Prospect, the cow that averaged 30½ gallons of milk for 365 days.

TUBERCULOSIS IN CATTLE AND PIGS.

By Chas. R. Turbet, B.V.Sc., Government Veterinary Officer.

Tuberculosis is the most common and serious disease of stock in Fiji. All classes of animals are attacked by the disease, but it is more commonly found in cattle, pigs, fowls and human beings. It is a chronic infectious disease and often animals may be infected for a considerable time before manifesting any visible signs of the disease. The cause is a specific organism known as the tubercle bacillus.

Method of infection.—Ingestion of the causal organism is by far the commonest method of infection, that is to say, the germs which cause the disease are taken into the body with the food. In adult cattle, grass contaminated with saliva and other secretions from infected cattle is the commonest source. When calves become infected, it is usually through drinking the milk from, or suckling an infected udder. Tuberculosis is rare in pigs, except when reared in the environment of an infected dairy. In this case the disease is contracted through the drinking of separated milk from tuberculous cows. Pigs also contract the disease through eating the carcases of animals dead from tuberculosis, and also at times from animals destroyed on account of the disease which have not been either completely burned or buried deeply. When animals are housed the disease may be conveyed from one to another through breathing contaminated atmosphere.

Dangers from tuberculosis.—These lie chiefly in the fact that there is grave danger of human beings contracting this chronic, incurable, infectious disease from our domesticated animals. On the other hand there is considerable economic loss through the falling off in milk secretion and interference with milk supply, and in the beef trade, through the condemnation of whole or parts of affected carcases.

Symptoms in cattle.—Enlargements of the lymphatic glands are, in Fiji, fairly diagnostic of tuberculosis. These gradually increase in size, when they remain constant. They are found in order of frequency, in the following locations (*a*) in the throat, causing a swelling at the junction of the head and neck; this may be so large as to cause considerable pressure on the larynx or entrance to the windpipe and is accompanied by a snoring or snuffling noise in the majority of cases. At the same time the head is held

in a stretched out manner, about in the same line as the neck, both the head and neck being depressed; (*b*) under the ear, (*c*) at the point of the jaw, (*d*) in front of the shoulder, (*e*) above and behind the udder, or in the bull along side the cord above the testicle, (*f*) in the flank. Tuberculosis of the lungs may be manifested by a dry harsh chronic cough seen particularly when the animal is made to exert itself, while a slow progressive loss of flesh from no apparent cause, other members of the herd remaining fat and sleek, is often diagnostic but not invariably so. Harshness of coat and general unthriftyness are suspicious symptoms. In spite of these given symptoms, animals with advanced tuberculosis may show no manifest symptoms of the disease and remain in good condition for a long time unsuspected. This enhances the danger to children and young animals from drinking the milk of such a cow. Persistent diarrhœa is also a symptom, but not a common one.

Tuberculosis of the udder is perhaps the most dangerous form of the disease and besides the above-mentioned swelling of the lymphatic glands it may be evidenced by a hard, diffuse painless swelling toward the base of one or more quarters. At first there is no alteration in the milk, but later on, after weeks or months it becomes thin and watery containing clots.

Symptoms in pigs.—These are not definite. Enlarged glands are difficult to detect owing to the fat, but if the pig is lean and the glands large, they may be seen. A slow steady loss of condition is suspicious of tuberculosis, but in Fiji this usually denotes severe worm infestation.

Post mortem appearances.—In cattle abscesses from the size of a pin's head to that of a baby's head may be seen. They are usually found associated with lymph glands, and more commonly those of the head, lungs, liver and intestines. The abscesses may, and do frequently occur in the substance of the lungs, liver and more diffusely in the mammary glands; rarely in the kidneys, heart, testicles and other organs. In some cases tubercle or nodular bodies are found spread over and adhering to the lining of the chest cavity, the surface of the lungs or abdominal contents or the lining of the abdominal cavity. The contents of the abscesses are yellow in colour and may be of the consistancy of custard, or firm and cheese-like, not so often, firm and gritty.

In pigs the lesions are seen in the same locations as in cattle, but at times the bones are affected, more particularly the back bone. The tendency for generalisation of the disease is greater in the pig than in cattle. The colour of the pus in pigs is dirty greenish white, and is usually gritty.

Treatment.—There is no known cure for tuberculosis, and the treatment of the disease in domesticated animals is useless.

Control.—The stock owner is in a position to very materially assist in the eradication of tuberculosis. He will be doing a good turn to himself and mankind if he immediately destroys any beast showing the above mentioned symptoms. The Contagious Diseases (Animals) Ordinance states that an owner shall notify an inspector under the Ordinance if he has a diseased animal, but it is far better to destroy at once, except of course when the owner is only suspicious, when he should seek advice if obtainable.

In feeding calves and pigs exercise the greatest care and cleanliness. Use metal utensils which can be scalded and thoroughly cleaned after use. When the herd has not been shown to be free from tuberculosis by the tuberculin test, then all milk fed to calves and pigs should be sterilised by heating to 180 deg. F., and keeping it at that temperature for 15 minutes.

We can only hope to control the spread of tuberculosis in Fiji at present by the destruction of all animals showing symptoms of the disease. In

more prosperous times in the future it may be possible to apply the tuberculin test to all dairy stock with suitable disposal of reactors. The accredited herd system may be then adopted, which means that a herd which on three successive applications of the tuberculin test with six months interval, has failed to show a reactor becomes an accredited herd, and the value of such a herd greatly increased for obvious reasons. New stock entering such a herd must be tested and found to be free before admission. This system cannot be carried into effect in Fiji at present, but it is an ideal to be strived for.

Other references to tuberculosis are contained in Pamphlet No. 32.

SUGGESTIONS FOR THE FEEDING OF CALVES.

By Chas. R. Turbet, B.V.Sc., Government Veterinary Officer.

When dairying is the chief object, the young calf should be removed from association with its mother at birth or soon after. The practice of allowing calves to suckle their mother is bad from the milk production point of view. By not allowing the calf to suckle, and by regular and thorough milking, the milk yield increases. It is essential however that the young calf should receive the first milk from the mother. This milk contains a substance known as colostrum which has a laxative action on the bowels. Nature has provided this substance to clear the bowels of the young calf of the contents accumulated during its life within the cow.

On removal from the mother the calf should be kept separate, handled and taught to drink from a bucket by the finger method, that is, two fingers are placed in the calf's mouth; the hand, which should be quite clean, is held below the level of the milk. The calf then sucks the fingers and gradually learns to drink from the bucket without the aid of fingers. The feed at this time should be mother's milk, the quantity about 1½ gallons divided into four feeds in 24 hours. The milk must be fed at blood heat. After two days transfer the calf to the calf herd and feed for two weeks on whole mother's milk three times a day. Then gradually change the diet from whole milk to skimmed milk with a cream substitute such as the following:—Crushed linseed, 1½ lb; pollard, 1 lb. Stir well into two gallons of water, heat up to boiling point and boil for 20 minutes. When cool, this forms a jelly. To each gallon of skimmed milk add one pint of the jelly, also a wineglassful of lime-water. Each calf should receive one gallon of this morning and evening. Only add small quantities of the jelly at first till the calf becomes accustomed to the change in flavour of the ration.

The calf after about three or four weeks can graze a little for itself and derive some nourishment. It should also be allowed as much as it can consume of a mixture in the following proportion:—1 lb rice bran, 1 lb crushed maize, 10 lb chopped para. At four months the calves are fit to turn out to graze, but if milk food is available they should be kept on it as long as possible after four months.

In all cases of feeding calves, discretion must be exercised to determine the quantity of food to be given daily. Robust, vigorous and forward calves require more food daily than undersized or weakling calves. Avoid leaving any food to become stale or fermented for the following meal. Calves should always have access to rock salt. There is some difficulty in Fiji of obtaining concentrated foods such as grain and oil-cake, &c. This should be secured whenever an opportunity offers.

To make lime-water place a few buckets of slaked lime in a wooden barrel, cover well with clean fresh water (rain water), stir well with a clean stick. When allowed to settle it forms a clear, colourless and odourless liquid, possessing a peculiar alkaline and earthy taste. Water will only dissolve a ½ gram to the fluid ounce or 10 grams to the pint, hence no anxiety need be felt as to its strength. This can be given with confidence to young stock, such as foals, calves, pigs, as a corrective and antacid. It renders curd in milk less dense and more digestible and tends to prevent scouring. When the lime water-cask is emptied, fill it up again with water, stir well and allow to settle. In time all the lime will be dissolved. This is detected by the lime-water losing its earthy alkaline flavour. Then more lime is required in the cask.

The necessity for absolute cleanliness in the management of calves cannot be too strongly stressed. White-scour can be prevented by good hygiene. All milk-containing utensils should be washed and scalded after use, calf sheds should have clean concrete floors. Lime-wash should be liberally used and all fæces should be removed frequently.

TREATMENT OF PARASITIC GASTRITIS.

By Chas. R. Turbet, B.V.Sc., Government Veterinary Officer.

In the treatment by drenching of yearling cattle for Parasitic Gastritis, the following instructions should be carefully observed where the bluestone (copper sulphate) and mustard drench are used.

Take an enamel bucket, put in five pints of carefully measured rain water. In this dissolve one ounce of bluestone (copper sulphate), and later on add one ounce of common fresh mustard. It would be advisable to warm the water to accelerate solution of the copper sulphate, but it should be quite dissolved and the solution thoroughly cooled before the mustard is added.

The dose of this for a yearling is eight fluid ounces, a lesser proportion for younger calves. Keep well stirred the whole time. The above quantity is sufficient for about twelve yearlings or more calves. Food should be withheld from the animals to be treated for 24 hours before treatment. Withhold water for some hours after drenching. Eight fluid ounces equals one breakfast cup.

This remedy may be repeated if necessary after an interval of ten days, and then monthly for about six months.

DIRECTIONS FOR MAKING BLOOD SMEARS.

By Chas. R. Turbet, B.V.Sc., Government Veterinary Officer.

1. Place a small drop of fresh blood near one end of a perfectly clean grease free microscope slide.
2. Carefully lower the edge of a second slide through the drop of blood on to the surface of the slide upon which the drop of blood has been placed.
3. This second slide is held at an angle to the first slide, and the small drop of blood by capillarity spreads itself out in the angle between the slides.
4. The edge of the second slide is then stroked along the surface of the first slide and the blood is spread out in a thin film over the surface of the slide.
5. Dry in the air.

DIRECTIONS FOR SALTING HIDES.

By Chas. R. Turbet, B.V.Sc., Government Veterinary Officer.

1. Open the hide out fully and lay it hair downward on a flat surface, preferably cement or wood, upon which salt has been spread.

2. Cover the inside of the hide (uppermost) with strong coarse dry salt to the extent of not less than 12 pounds per hide. Build up a stack in this way by laying one hide upon another with the layer of salt between them. The brine should drain freely from them.

3. The hides should remain in the stack at least seven days.

4. When salted, each of the hides shall be turned in from the head, then from the butt and then folded up so that the salt shall be retained and every part of them shall some in contact with it.

PREVENTION OF PLANT DISEASE.

By J. G. C. Campbell, B.Sc., Mycologist.

Before dealing with the prevention of disease it is necessary to know something of the plant in health, the conditions under which it lives, and the agents which produce disease and their effects.

The Plant.

Plants consist of roots, which fix them in the ground and absorb their food materials; the stem which carries the leaves, which take in air and give out water, and flowers, from which the seed is produced.

The food of plants is obtained from the soil in which it grows and from the air. The most important requirement is water, this substance in some instances comprising ninety per cent. of the total weight of the plant. In the absence of sufficient water the plant wilts and dies of drought; an excess suffocates the roots, causing their death and the consequent death of the plant. It is as a solution in water that most of the other plant foods are taken into the plant.

There are a number of substances essential to the growth of the plant. Some of these are—

Carbon, which is obtained from the carbonic acid gas in the air;
Nitrogen, obtained from the soil as nitrates;
Phosphorus, obtained from the soil as phosphates;
Potash, obtained from the soil as chemical compounds or salts;
Calcium, obtained from the soil as some form of lime.

All these, and several others are of such importance that, in their absence, the plant will scarcely remain alive, or at the best, will be weak and sickly. A deficiency of any one will result in poor growth as the plant not only suffers directly from the lack of that particular one but is unable to make the fullest use of the others, however abundant they may be. These deficiencies may be remedied by the application to the soil of suitable fertilizers containing the missing substances. For example, kainit would supply potash, superphosphate, phosphorus and lime and saltpetre nitrogen.

These minerals are dissolved in the water in the soil and are absorbed through the roots. They pass up through special channels in the stem till they reach the leaves. There they meet with the carbon which has been taken in by the latter as carbonic acid gas. By the action of the green colouring matter and sunlight, they react with each other to form new compounds such as sugar. These are carried away again by another set of vessels and distributed to the growing parts of the plants, where they are used to form new tissues.

Much of the water which is taken to the roots is given off from the plant by means of pores on the surface of the leaves. This process is known as transpiration and is automatically regulated so that only the right amount of moisture is lost.

Plants breathe just as animals do. The air is absorbed over the whole surface of the plant from the roots to the highest branch, and any interference with the process is detrimental to the health of the organism.

The Surroundings of the Plant.

The environment in which the plant grows frequently has considerable effect on the state of its health and, in some, cases, is responsible for definite disease. It will be treated under the following four sections:—

1. The atmosphere;
2. Water;
3. The soil;
4. Climate and weather conditions.

1. *The Atmosphere.*—The atmosphere is of importance because it is the sole source of all carbon, and of most of the oxygen which the plant requires. The average composition of the air is: nitrogen, 79·02 per cent.; oxygen, 20·94 per cent.; carbonic acid gas, 0·04 per cent.

Near factories the air contains, in addition to these gases greater or less quantities of other gases which have an injurious effect on plants. These are found especially in the neighbourhood of chemical works and smelters, and it is not unusual in places where these are situated to find the ground quite devoid of vegetation for a considerable distance round.

The air also contains suspended matter such as smoke and dust. The dust may contain among other things, the spores of disease producing fungi.

2. *Water.*—Rain is, directly or indirectly, the natural water supply of plants. Irrigation water is drawn from rivers, wells, and bores. Usually, these sources provide a safe water. In the case of certain artesian bores, however, the water is so charged with mineral matter as to cause the death of plants to which it is applied.

As mentioned before, the right amount of water is necessary for healthy plant growth. A deficiency causes drought. This may be remedied by irrigation. On the other hand, excess of water is just as injurious, as it causes suffocation, death, and decay of the roots. This may be remedied by suitable drainage.

Water sometimes carries the spores or germs of disease.

3. *The Soil.*—Ths soil is perhaps the most important factor governing the growth of plants. Soils are derived from rocks by the decompositon of the latter by air, water, wind, and other natural agencies, and their nature depends largely on the nature of the rocks from which they are formed. The soil may be discussed under three heads—

1. Its physical condition;
2. Its chemical composition;
3. Its biology.

1. *Physical.*—Soil consists of small particles, very fine in some cases such as clay; very coarse in others as in some sandy soils; of intermediate size or mixed in the remainder.

Sand holds less water than clay; it makes the soil in which it is contained more or less friable according to the amount present; it drains rapidly and gains and loses heat rapidly. Clay in a soil binds it; it holds more water and does not drain readily. Under certain conditions, a clay subsoil may become consolidated forming " hard pans " which will not allow water to

pass through either from above or from below, and are too hard even for the roots to penetrate. Such a condition of course is very undesirable for any crop.

Water is present in all soils to some extent, even in the driest. Of the water which falls on the surface of the earth as rain, much percolates through the soil and accumulates below forming a vast reservoir. The surface of the water in this reservoir is known as the "water table"; it may be at any depth, and varies from season to season. When it is on the surface the soil becomes waterlogged, or even marshy, and the ground will not grow anything but a few water plants or reeds. Much land of this nature can be reclaimed and made to produce prolifically by putting down a system of drains which carries off the water before it rises to a dangerous level. Usually, the water table is at a greater depth. The soil above is then kept moist (without being wet) by the water which rises just as kerosene rises in the wick of a lamp. It is drawn right up to the surface from whence it passes off into the air as a vapour, that is, it evaporates. In places where the rainfall is slight, or is irregular with long spells of dry weather, it is important to conserve the water as much as possible, and prevent this evaporation. This is done by means of surface mulches of straw or trash or by frequently stirring the top inch or two of the soil.

The water in a good soil exists as a film covering each particle. In between the particles is air from which oxygen is absorbed by the roots. In a waterlogged soil, this air is displaced by the excess of water. This is why the roots become suffocated and the ground requires draining.

2. *Chemical.*—The chemical nature of the soil depends on the nature of the rocks from which it was derived, the amount of water which falls on its surface and the drainage.

The fertility of the soil depends largely on the amounts of the various plant foods which are available in it, and the ordinary chemical analysis attempts to determine this. The constituents which are of most importance are potash, phosphate, and nitrogen. The available plant foods are present in a soluble form and rain washes away large amounts of them, some constituents being affected more than others in this respect. The only reliable way of determining the deficiences in these minerals is by systematic experiment with fertilisers on the particular kind of crop being grown. When this is determined, they can be adjusted by using suitable manures.

Soils may contain substances which are directly injurious to plant life such as common salt, magnesium salts, soda, &c. The remedy for these is not always satisfactory, and in America, where large tracts of alkali soils (as they are called there) exist, the problem is a serious one. In the neighbourhood of certain factories, certain substances find their way into the ground and cause trouble to the vegetation.

3. *Biological.*—The soil is teeming with life. Around the soil particles live myriads of very minute plants and animals which play a very important part in the maintenance of soil fertility. They include bacteria, fungi, and microscopic animals of primitive form known as Protozoa. The function of these organisms is to break up the complicated compounds which comprise the bodies of dead plants and animals into the simple substances from which the latter built them up in life. Carbon and nitrogen are returned to the air, and nitrates, sulphates, phosphates, &c., to the ground so that they can be again utilised by a new generation of plants.

In the soil also exist other bacteria which are able to use the free nitrogen in the air for their food requirements—a thing which the higher plants

cannot do directly. Certain of these are found in the nodules which are to be found on the roots of plants belonging to the same family as the beans and clovers. They take up the nitrogen from the air and, as they become old, are digested by the plant on which they live, the latter thus obtaining a supply of the gas independent of the soil. These crops are high in nitrogen and when ploughed into the ground, enrich it considerably with this substance.

All these bacteria work best in a soil which is moist without being wet, is warm, not too acid and well aerated. Cultivation which produces this condition is directly beneficial to the crop plants, and benefits them indirectly also by stimulating the action of the minute organisms which play such an important part in the improvement of the soil.

In addition to these useful microbes, the soil, in fields where certain diseases are prevalent, contains disease producing ones. Some of these grow in the soil quite independently of a host plant; others exist only in the form of spores, waiting only for the advent of suitable plants, which they cause to become diseased.

Climate and Weather.

It is hardly necessary to mention the relation between climatic conditions and agriculture. Every planter and farmer knows it from experience—often very bitter experience. There are however certain weather conditions which must here be mentioned on account of the injury which they cause to plant life.

Very hot weather causes sunburn, denoted by the withering and browning of the leaves after exceptionally hot weather. Frost also causes death of parts of the plant. Hail causes mechanical injury which is often severe. Strong winds also cause much damage as is unfortunately the case at times in Fiji.

Infectious Diseases.

These diseases are caused by specific parasites and, "No parasite, no disease." They are to be distinguished from the diseases which are caused by some condition in the environment of the plant, such as lack of water, or excess of salt in the soil. Those of the latter type are often known as "Physiological Diseases."

The principal groups of organisms causing infectious diseases are the fungi and the bacteria. Sometimes flowering plants are parasitic on their relations and cause a good deal of trouble. One example, very common around Suva, is the Dodder; another is the Mistletoe, native species of which are found in Fiji. Weeds, although not parasitic, sometimes cause injury to crop plants by overcrowding them and thus depriving them of air and sunlight. This however is usually the fault of the grower. The higher animals, including man, may directly or indirectly injure plants. Gnawing animals such as rabbits injure the bark; and many people deliberately and without purpose cut or otherwise damage plants of all kinds. But it is not until a much lower level is reached in the animal scale that true parasites are found. These are the Nematodes or Round Worms, a typical example of which is the notorious hookworm. Several minute representatives of this group are known to attack plants. The most common one perhaps is the Eelworm, or Gallworm which is found in the roots of many plants where it causes the formation of little swellings or galls, and by interference with the function of the roots, leads to the death of the host.

The Fungi.

The fungi include a large number of very different looking organisms. The pin mould which is often found on bread, the green and blue moulds which

are so common on various articles in Suva just at present, yeast, mushrooms, and the bracket fungi which grow on dead trees and stumps are all examples of fungi.

One of the main points which characterises both fungi and the bacteria is the absence of the green colouring matter which is found in other plants. Because of the absence of this they are unable to avail themselves of the carbon of the air for food and are compelled to derive it from other sources. These sources are the dead or living bodies of plants and animals. When they derive their nourishment from and at the expense of living organisms, they are known as parasites.

Fungi, in most cases, consist of delicate threads known as the " mycelium," which ramify through and absorb food from the substances on which they live. In the case of parasitic fungi, the mycelium grows among the cells of the host, absorbing from them their contents and thereby causing their death. After growing thus for a time the fungi forms spores which may be likened to the seed of the flowering plants; when they are planted in suitable places, and supplied with warmth and moisture, they germinate and form a new plant.

The mycelium is delicate and is easily killed by drying or heating. The spores, on the other hand, are scarcely affected by drying and can withstand a considerable amount of heat, although boiling is fatal to them in a few minutes.

The spores may be produced on the exterior of the host plant, as is the case with rusts and smuts, or they may be formed inside the tissues, and liberated only when the plant dies and decays.

Fungi are spread principally in the form of spores. These are carried about in various ways. The commonest way is by wind, Spores are very small and light; individually, they are invisible to the naked eye, and can be distinguished only with the aid of a microscope, but when they are in quantity, they look like dust or smoke, an appearance which may be noticed if a mouldy bag be knocked. Those which are formed on the surface of a plant are readily displaced and are transported from place to place by the lightest breeze. The distance which they might be carried thus does not exceed more than a few miles.

The spores may be transmitted from one plant to another alongside it by direct contact, or they may be splashed over in rain drops. In some cases, the spores, when mature, are forcibly ejected into the air. Insects often assist in their distribution; in one particular case, the fungus has an odour which is very objectionable to humans, and very attractive to blowflies. These insects feed on the plant, ingest the spores and fly away and deposit them, perhaps at some considerable distance away.

Soil fungi may be distributed by irrigation or drainage water. They may also be carried from place to place on ploughs and other implements, and on the feet of labourers and animals.

The fungus itself may be distributed in infected sets. These may be apparently healthy, but after they have grown for a time, the disease manifests itself and infection of the field occurs. Care should be exercised, therefore, in obtaining suckers for new plantations.

A notable fact about fungi is that many of them possess two or more forms, and so different are these in appearance and in the type and mode of formation of their spores that, in the early days of mycology, they were described as different species. Frequently, these different forms grow on different plants. This is well illustrated with wheat rust in cold climates. The usual form of rust is on the wheat plant. On a plant known as the bar-

berry, the disease occurs in another form, and from it, wheat may again become infected with ordinary rust. In certain places, a marked diminution in the amount of rust followed the eradication of the barberry.

The one fungus may attack a large number of plants of different families, or it might confine its attentions to one species only, and, at times only to certain strains of that species.

The life history of fungi varies much in complexity. Where a number of different forms exist and attack different host plants, as in the case of rust, just mentioned, the whole process is very intricate. In the simplest cases, however, it is not at all complicated. The spore comes to rest on the surface of a suitable plant and, in the presence of the droplets of moisture which are usually present there, germinates. A little tube is pushed out from it and enters the tissues of the host, either by actual penetration of the surface, or through the breathing pores or a wound left after some injury, for example, an insect bite. Once inside the plant, the germ tube pushes its way between or through the cells and so ramifies through the tissues and forms the mycelium. When the fungus is mature, branches of the mycelium are pushed out at the surface again, and from them spores are formed. These are carried by various means to other plants where they germinate and go through the cycle again.

Bacteria.

Bacteria are similar to fungi in many ways, differing principally in that they consist of only one cell, and are very minute, an average length being about one-twenty-five thousandth of an inch. Many bacteria form spores which, like those of fungi, are resistant to drying and heat, but few, if any of those causing plant disease exhibit this phenomenon. Bacteria are distributed in the same way as fungi, but air carriage, so important in the case of othe latter organisms, is of little importance in connection with the former. Soil and water infection, and infection by means of pruning knives and insects are probably the most common methods.

Symptoms of Disease.

The principal signs which show that something is wrong with the plant will now be given.

Discolorations.—These include all variations from the normal green colour, either over the whole plant or in patches. For example, deficiency of iron in the soil, or lack of light will result in the plants having a pale green or sickly yellow colour. A large number of fungi cause brown, red, yellow, or white spots or patches on the leaves of crops. Sunburn, frost, and injuries due to the use of unsuitable sprays or to insects may produce a similar appearance.

Shot hole.—This results in some cases when the centre of the brown spots drop out, leaving circular holes with perhaps a narrow margin of brown around them. Leaf eating insects may produce a similar appearance.

Wilting.—This is a general drooping and withering of the whole or parts of the plant. It may be caused by drought, waterlogging, or the attacks of insects or fungi which stop the passage of the sap from the roots to the leaves. In a localised form known as "die-back," the twigs and terminal branches are affected, and die off, the remainder of the plant being apparently healthy.

Rot.—This may occur in various parts of the plant, but usually attracts most attention when it is present in some succulent or fleshy part such as the fruit, or in tubers, &c., such as in the potato or yam.

Gumming.—This is denoted, as the name implies, by the exudation of gummy or slimy substances from infected parts of plants.

Various other symptoms will be noted. Sometimes there is malformation of the affected parts; sometimes dwarfing. In many parasitic diseases, the spores of the fungi may be noticed as a powder on the leaves or on the diseased patches, or they may appear as little black spots, or as pustules (as in rust). Sometimes in certain diseases the spores of the fungus are formed in little mushrooms which sprout up around the base of the tree. Every appearance which differs from that seen on the healthy tree should be noted and inquired into.

Cure and Prevention.

Physiological diseases can often be remedied by removing or otherwise remedying the cause, but, except in a few instances, such as the powdery mildews, there is no satisfactory *cure* for parasitic diseases. In some cases, surgical treatment can be resorted to and diseased parts cut away, but this is not always successful.

The old adage about prevention being better than cure has no truer application than to plant pathology. The principal method of controlling plant diseases is to prevent them. In the foregoing part of the paper an attempt has been made to describe briefly the plant in health and the causes of disease, as with some knowledge of the enemy and its methods of attack, it is possible to avoid it or at least to establish lines of defence.

The first principle is to maintain the plants in a healthy condition. This requires attention to the food supply, to irrigation or drainage, to tillage, to manuring, to light and air, and to protection, as far as possible, from the elements. All this is simply a matter of good farming, and of the study of the particular crop and the local conditions under which it is grown. There is another old adage which tells that "one man's meat is another man's poison," and the moral contained in this is applicable to plants just as much as it is to men. The treatment which will suit one crop will not suit another, and may not suit the same crop if the latter be grown in a different place.

It should be almost unnecessary to say that none but healthy plants should be used to start with. This can be ensured only by obtaining suckers or seed from an area where no disease exists. Clean plants in clean ground will produce a clean crop; clean plants in infected ground might give a healthy crop for the first year; but infected plants in either clean or infected ground will never give an healthy crop.

A close watch should always be kept for the first symptoms of sickness, and more especially if disease has occurred in the district. When these are noticed, the plants should be kept under closer observation, and, if necessary, prompt and drastic measures taken The important thing is to recognise the disease early. It is also important that that the planter should have some idea of the more serious diseases which might at any time occur among his crop, and, in order to supply this information, leaflets will be issued by the Department of Agriculture, and made into pamphlets giving the symptoms and standard treatment for such diseases. The actual measures to be adopted in any particular case will vary, of course, according to the local circumstances. There are, however, a number of general measures which can be adopted.

First, there are what might be termed sanitary measures, which deal with the cleaning up of infectious material. For example, in leaf spot diseases, the spores of the fungus are formed on the leaves; when the latter die and fall off, and are blown about the ground, or carried, accidentally or on purpose, to some other place, the spores go with them, and so the disease is spread around. If, however, the leaves are removed from the trees when it is obvious that they are dying, and are burnt, the spores will

be destroyed before they have the opportunity to spread to any extent, and in many cases, before they are formed. In the case of a plant which is dead of some root or stem disease, the same principle should apply. The plant should be dug out and burnt when it is obvious that it will not be healthy; the soil in the hole and round should be disinfected and should not be replanted for a year or so. If it remains standing, it is a centre from which the disease might spread to other plants, and when it decays, the parasite will be liberated in the soil which will remain infected perhaps for years.

Disinfection of the soil may be carried out by saturating it with a solution of formalin (1 part of formalin in 100 parts of water) and covering with bags for a few days.

Spades and knives and any other implements used in dealing with these infected plants should also be sterilised by immersing for an hour in the above formalin solution.

In the case of air borne diseases, spraying healthy plants will minimise and even prevent infection. Spraying is a method of prevention and not of cure. Once a disease has entered the plant, gallons of spray may be applied without it having the slightest effect. The object of spraying is to cover the leaves with some substance which will kill the fungus as soon as it emerges from the spore. The two sprays most frequently used are Bordeaux mixture and lime-sulphur. Bordeaux is prepared by mixing in the right proportions, milk of lime and bluestone solution. It is used in various strengths and there are numerous modifications of it. Lime-sulphur is prepared by heating together a mixture of lime and sulphur with water. Both are applied by means of spraying machines which vary considerably in size and efficiency from the common bucket spray to the power sprays which are driven by an engine.

Sometimes powdering is resorted to instead of spraying, and, in America, this method is now being used to a considerable extent, special machinery having been devised for applying it on a large scale.

Fumigation with hydrocyanic (prussic) acid is used against insects, and is very efficient, but it is not necessarily effective against fungous diseases, as is popularly supposed.

When pruning trees, a coating of tar or paint over the cut surface will prevent the entrance of fungi at this point. If a diseased tree has been pruned, the knives, &c., should be carefully disinfected before using them on another tree.

If disease does become established in spite of all precautions, rotation of crops, which is used in ordinary farming practice becomes absolutely essential. If a sufficient time be allowed to elapse during which a parasitic organism is deprived of a suitable host plant, the disease will in many cases, die out. This might occur in a year or two, or it might require several years. The strict application of this practice at the beginning of an outbreak would often save much trouble and loss in the long run.

Finally, in some cases the loss from the disease can be eliminated by the use of resistant varieties of the plant. This has been used very successfully with wheat rusts and sugar-cane diseases. Resistant plants can often be obtained by systematic breeding and selection, but years might elapse before a suitable strain is found.

This concludes the paper. A subject such as Plant Hygiene treated in such a short space must necessarily be very sketchy, but it is hoped that, even from this outline, something will be gleaned which will enable those who hear it to maintain their crops in a healthy condition.

THE INTRODUSTION OF USEFUL INSECTS.

By Arthur M. Lea, F.E.S. (on loan from South Australian Museum).

The acclimatisation of destructive insects in countries distant from their native homes has often resulted in immense damage, and has been a constant heavy tax on producers; not infrequently it has caused the abandonment of attempts to grow the attacked plants. Fruit flies, blow flies, bot flies, sheep tick and scab, many kinds of scale insects (including the San Jose scale), and aphides (including the *Phylloxera* of the vine), codlin moth, potato and gipsy moths, cabbage moth and butterfly, grain weevils, and pear slug are familiar examples, and numerous others could be cited. In their native homes they are generally comparatively harmless, and are always much less destructive than when introduced into fresh surroundings; where, often unaccompanied by their own parasites, the checks to their increase are inefficient.

Cottony Cushion Scale and its Control.

The first notable success in the pitting of its natural enemies against a destructive insect was the introduction by Mr. Albert Koebele of a small Australian ladybird, *Novius cardinalis* (often called *Vedalia*), to fight the cottony cushion scale in America. This scale (*Icerya purchasi*) originally came from Australia, and did enormous damage to the orange groves of California, and was threatening them with extinction; yet, within two years of the introduction of the ladybird, it increased to such an extent that the scale was efficiently controlled.* The same entomologist introduced another Australian ladybird (*Cryptolæmus montrouzieri*) to Honolulu, where it checked the sugar-cane mealy bug which had become a serious pest. Incidentially I will mention that within the last few weeks, at the instance of the Department of Agriculture, I have brought with me colonies of this useful ladybird to check the mealy bug, principally on pineapples.

Encouraged by these examples numerous attempts have been made to introduce useful insects to keep destructive ones in check, sometimes with great or moderate success, but often with no appreciable result.

Factors to be considered.

In the attempt to introduce a useful insect into fresh surroundings many factors need to be considered, including its own life-history; the life-history of the pest to be controlled; and the alteration under cultivation of the plant attacked.

As regards the pest itself, an insect that has but one or two broods in a year obviously cannot increase to the same extent as one that reproduces itself every few days, or weeks, such as the house-fly, aphides, scale insects and some moths. Nevertheless, slow-breeding species such as some plant weevils, the codlin moth in cold climates (where it is single brooded) and others that live underground or deeply buried in fruit may, from the almost total absence of controlling insects, become major pests; whilst rapid breeding insects may, from the multitude of their natural enemies, never become serious pests. Quick breeding insects, such as aphides and some scale insects, even when introduced into fresh surroundings, are usually preyed upon by local insects, and these in time usually keep them in partial subjection.

Obviously any insect that lives exposed during its whole lifetime, such as scale insects, some aphides, and numerous moths and beetles, or even during

* Both this labybird and the scale it attacks are widely distributed in Fiji, and for that reason the scale is not a pest here.—Ed.

a lengthy part of its life, is potentially capable of control, if its natural enemies can be introduced free from their own, and the surroundings are favourable to their multiplication.

Cultivation and Selection a Disturbing Factor.

Cultivation, however, and plant selection have increased the size of so many fruits that the natural factors cannot be reproduced. Thus the apple, originally a fruit not much bigger than a cherry, has been enormously increased in size, with the result that certain ichneumon parasites which in the wild apple could quite easily deposit their eggs within the bodies of the codlin grubs now find it impossible to do so, and they can be reached only after they have left the fruit; or by minute parasites that attack the eggs. Similarly with fruit flies; the Queensland fruit fly in certain wild fruits and berries suffers rather severely from the attacks of small hymenopterous parasites, but in the larger cultivated fruits it is practically exempt from these, as even the eggs are thrust below the skin, with the result that the pest can only be reached after it has left the fruit. With sheep-attacking blow flies the great increase in the length of the wool enables most of the maggots to burrow far below the distance at which they can be reached by parasites, and it is only after they have left the sheep to pupate that they can be reached. Thus during long periods of their existence certain insects are practically immune from attack except by artificial means.

Difficulties of Introducing Insects.

Even after the controlling parasites of an insect have been found their introduction may be attended with great difficulty. Many insects are short lived, some are not readily reared or kept in captivity, some must be kept continuously moist (and under artificial conditions it is difficult to keep them from being destroyed by moulds). Some parasites that live within the bodies of their hosts require to change to the pupal stage in the ground. Great heat may prevent the introduction of an insect from north to south of the equator, and *vice versa*.

On the other hand many insects are capable of being kept for comparatively long periods under absolute starvation, and at the end of those periods to feed, and reproduce themselves, with their accustomed vigour; for instance, I sent two parcels of ladybirds (*Leis conformis*) by post from Tasmania to England, and of these a fair percentage arrived alive.

Some predaceous beetles (such as *Carabidæ* and *Staphylinidæ*) may also be easily introduced, as in captivity they will feed on a large variety of insects, maggots being acceptable to many of them. Some will also eat raw meat if this is fresh and supplied in minute amounts. Thus the *Plæsius javanus* beetle, predaceous on the banana borer and one of the cane borers, readily gorges on chopped fresh meat.

It has been found that some insects can be transported for long distances if placed in the ice-chambers on board ship, and that they will recover their full vigour if slowly thawed at the end of the voyage.

Useful Insects.

Hymenoptera.

Useful insects are not confined to one order only. Large groups of *Hymenoptera* are entirely parasitic in habits, but many of the parasites attack useful insects as well as destructive ones. Few large larvæ altogether escape the attacks of ichneumon wasps, several thousands of which have in many instances been reared from single specimens of large wood-boring

larvæ, and frequently on examining a dried aphis a small hole from which a parasite has emerged may be seen. Scoliid, thynnid and other wasps destroy large numbers of cockchafer beetles (such as the destructive sugar-cane beetles) and other insects. Immense numbers of small chalcid and proctotrypid wasps attack the eggs, larvæ and pupæ of moths, scale, aphides and other insects. Some wasps, such as the so-called policeman flies, carry off insects or spiders to store as food for their larvæ, either in holes underground or in mud cells, which they construct under or on stones, or even in houses.

Even internal feeders, such as the larvæ of many ichneumon wasps and tachinid flies are often themselves attacked; and so instead of a true parasite appearing from an insect attacked by it, some small hymenopterous or dipterous parasites may emerge. These secondary parasites (hyper-parasites) have always to be guarded against, as if once introduced the benefits to be obtained from the original parasites may be altogether nullified. The hyper-parasites are usually hymenopterous, but occasionally are dipterous.

Ants (white ants or termites are not here referred to) forming one of the most important groups of hymenoptera, are probably never entirely useful, or entirely destructive. Many of them must be regarded as injurious, as they protect aphides and mealy bugs against the attacks of other insects, forming covered ways or galleries for them, taking them to their own nests, and even carrying them or their eggs to the roots of plants for protection during the winter; the reasons being that the protected insects give off a nectar-like substance—honey-dew—that ants greatly relish, hence such aphides or mealy bugs are sometimes referred to as the cows of the ants A few ants store up grain, but the majority of them seize any insect that comes along, and in this connection have proved of some use against maggots of fruit flies, grasshoppers (especially when egg-laying), termites, &c. Every ant, however, that has been introduced, purposely or accidentally, to fresh surroundings has became a nuisance.

Diptera.

In the diptera, or flies, the family *Tachinidæ* consists of an enormous number of species (some of them greatly resemble house flies) the majority, of which are useful, as they destroy the larvæ of moths and butterflies, grasshoppers, beetles and other insects. Some of them attack adult beetles at sundown and night, and deposit white eggs on them, the shells of which remain on the beetles even after the maggots have entered their bodies. Frequently the maggots of these flies, when in the body of an insect, are in excess of the food supply, and as they near maturity and find their proper food exhausted, turn on each other so that few survive.

Syrphus (or hovering) flies in their larval stages destroy large numbers of aphides and scale insects and many small caterpillars; unfortunately, their own larvæ are severely parasitised by small ichneumon wasps.

Robber flies (*Asilidæ*) may frequently be seen carrying of insects much heavier than themselves, and many other predaceous and parasitic flies are known. Even mosquitoes have been recorded as destroying pupæ of butterflies.

Coleoptera.

Of the beetles (or *Coleoptera*) very few true parasites are known, but some families are almost entirely predaceous, their species feeding on such insects as they can seize; few confine themselves to attacking definite groups of insects. The largest family of predaceous beetles is the *Carabidæ*, and it consists of about one-tenth of the order. The species of *Calosoma* (large

green beetles) are seldom seen in daylight, but at night they wage constant war on many moth larvæ and *C. schayeri* is responsible for keeping some of the most destructive cutworms in Australia in partial subjection. Efforts have been made to introduce the European *C. sycophanta* into the United States to feed on the larvæ of the gipsy and brown tail moths. The Lebiides (of which extremely few are present in Fiji) are abundant under bark in Australia, and many could be easily introduced.

Even more important than the *Carabidæ*, although less numerous, are the ladybirds or *Coccinellidæ*. These are divided into two groups, one of which is wholly insectivorous, the other wholly vegetarian. Many of the insectivorous species have been introduced to various parts of the world to feed on scale insects are ladybirds, and recently an attempt has been made to introduce two species to Fiji—*Leis conformis*, the most useful Australian species that feeds on aphides and scale insects; and *Cryptolæmus montrouzieri*, the most useful species that feeds on mealy bugs; *C. montrouzieri*, however, has recently been seen feeding on a species of cochineal insect that was introduced to Queensland with the hope of checking the prickly pear. The best known ladybirds are shining, and more or less spotted, but some of the smaller species are clothed with fine down and are black, or with inconspicuous markings; these (the scymnids) largely feed on scale insects, both in their laval and adult stages Many ladybirds eat the eggs of other insects, and one species has been seen occasionally eating the eggs of the coconut moth *Levuana iridescens*. Unfortunately, the larvæ of ladybirds are largely destroyed by small ichneumon and chalcid wasps, and by phorid flies, so it is usually considered too dangerous to liberate any but the mature insects, as was done in the recent importations to Fiji.

Plant-eating ladybirds are sometimes very destructive to the potato, pumpkin, and other solanaceous and cucurbitaceous plants, and unfortunately some of them so greatly resemble useful species that the latter are frequently killed in error by growers.

Beetles of the family *Cleridæ* are also often useful; many of the smaller and more brightly coloured ones live on flowers and capture flower-frequenting insects; others move about at night and destroy large numbers of boring insects, especially the shot-hole borers (*Bostrychidæ*, *Scolytidæ* and *Cioidæ*). There is a useful palm-frequenting species, *Cormodes darwini*, on Lord Howe Island that may be worth introducing to Fiji.

The rove beetles (*Staphylinidæ*), forming an immence family, are mostly scavengers, but some are insectivorous, and a Brazilian species feeds on maggots of fruit flies. Attempts (unsuccessful however) were made to introduce it to Western Australia. Other families of beetles are wholly or partially insectivorous, although some very large families are almost entirely injurious.

Stylopidæ.

Some singular insects, the *Stylopidæ*, by some naturalists referred to the *Coleoptera*, are parasites of bees, wasps, some hopping bugs and other insects. Several entomologists from the Hawaiian Islands and California visited Australia with the hope of obtaining some bug-attacking species to liberate in those countries; but although several species were obtained they have not been acclimatised abroad.

Hemiptera.

Of the bugs (or *Hemiptera*) one sub-order (*Homoptera*) contains but few useful species, the other (*Heteroptera*) or true bugs contains large numbers of useful ones, although the majority are destructive. Few of the useful species, however, confine their attacks to restricted groups of insects, but

are general feeders, killing and devouring such insects as they can seize, although many of them are seldom to be seen away from special groups of plants. The pirate bugs (*Reduviidæ*) and Pentatomidæ may often be seen on plants making off with caterpillars or other insects much heavier than themselves. Of the latter family one species has been recorded as attacking larvæ of *Levuana iridescens* and foreign palm-frequenting insects of this group, may prove to be useful if introduced to Fiji.

Orthoptera.

The order *Orthoptera*, containing as it does some of the worst insects in the world (the plague locusts), yet contains a few useful long-horned locusts, or katydids, and a few useful earwigs. One family is entirely useful, the mantidæ or preying insects. These usually lay in wait for unwary insects and seize them as they come within reach. Several have been introduced to different parts of the world to feed on destructive insects. To a certain extent they resemble some of the stick insects or *Phasmidæ*, of which one species is common on the coconut, but these are all leaf-eaters.

Neuroptera.

In the lace-winged insects (*Neuroptera*), many of which are aquatic as larvæ, the dragon flies and ant-lions are all predaceous, but they seldom attack insects troublesome to growers. One group, however, the *Chrysopidæ* (often called "golden-eyes") contains species that in the larval stage prey upon small insects and their eggs. Their own eggs are white, and each is placed at the end of a fine connecting thread.

Lepidoptera.

Nearly all butterflies and moths (*Lepidoptera*) are vegetarians and their larvæ devour many times their own weight of food in a day, except some of the timber-boring species, which are usually slow in maturing. A few species, *Thalpochares* (of the Noctuidæ), and some small Tineidæ feed on scale insects, but their usefulness is greatly minimised by their own parasites.

Spiders.

In addition to the true insects some other groups of invertebrates may be briefly considered here. Spiders, for instance, devour large numbers of destructive insects, but living as they do on almost any kind of insect that they can trap in their webs, or in the case of the hunting and jumping spiders that they can pounce upon, they can seldom be regarded as of much use against particular species. They have, in general, been neglected by naturalists, and this is regretable, as species habitually living on certain trees and shrubs might easily prove of use to such trees and shrubs when introduced to fresh districts. In connection with the coconut moth it will be desirable to study the habits of such spiders as live on palm trees. An immense amount of good is done by trap-door spiders, which destroy caterpillars and grasshoppers.

Centipedes.

Centipedes also eat many destructive insects, although usually only such as live underground, or that move about at night (as cutworms).

Worms.

Small thread-worms (nematodes) are sometimes found within the bodies of insects, but little is known about their habits.

Directly Beneficial Insects.

Bees, silkworms and other insects directly useful to man need not be considered here; nor those species that have been introduced to destroy noxious plants.

The Coconut Moth.

The life history of the small coconut moth, *Levuana iridescens*, is such that it would appear to be easily capable of control by its own natural enemies. The eggs are laid in clusters and are completely exposed, hence egg-attacking parasites such as chalcid and proctotrypid wasps and egg-eating ladybirds should have an easy task to find them, especially as they are laid on a limited variety of plants. The larvæ also are exposed during the whole of their feeding stage, and so could be reached by their parasites without trouble. On becoming full fed each larva spins a flimsy silken cocoon that can be no protection against insect parasites. The cocoons are spun separately and exposed, or are spun in mass, where the majority, if not all, could be easily reached by parasites.

The comparative freedom of the coconut moth from parasitic and predaceous enemies in Fiji renders it practically certain that it is not a native of the group, and until its natural home is found the chance of a successful introduction is remote, although there is a possibility that parasites of closely allied species may be useful. In the endeavour to find effective controls however, attention will not be confined to insects, as birds, frogs, lizards and diseases will all be carefully studied, whenever the native home of the insect be found.

INSECTS ATTACKING COCONUTS IN FIJI AND IN ADJACENT GROUPS.

By H. W. Simmonds, F.E.S., Acting Government Entomologist.

A brief synopsis of the coconut diseases of Fiji and of those in the adjacent groups, of which there is always a danger of their introduction, together with the methods used in those countries in their control should be of interest. The material for this account has been largely obtained by the writer in the course of a mission to Tahiti in 1920–21 to investigate scale parasites, a short visit to Wallis and Futuna in 1922, and a mission to New Guinea, Solomons and New Hebrides groups in 1923.

Diseases attacking Roots of Coconuts.

We have no record of any disease attacking the roots of coconuts in Fiji or the adjoining groups, although such are known elsewhere. One frequently, however, finds trees yellowing off from root trouble, generally on water-logged ground or on shallow soil underlain by solid rock.

Insects attacking the Trunk in Fiji.

Coleoptera.

Calandra taitensis, Guerin.—This is a small beetle about ¼ inch long and very like the common rice and flour beetle. It attacks the trunk, bases of leaves, and young nuts in Fiji, and this or an allied species is present throughout the whole Pacific area. No measures are at present taken against this beetle.

Sphenophorus obscurus, Bois.—This is the common sugar-cane weevil. It occurs in most of the Pacific area, and, whilst doing much damage to cane, is of little importance to coconut growers. The beetle is about ½ inch long, of a dark reddish brown colour, with a long black spot on the thorax and another one on each elytron. A *Tachinid* parasite has been introduced into the cane areas of Fiji to deal with this pest with considerable success.

Insects attacking the Trunks beyond Fiji.

Coleoptera.

A number of beetles are known to bore into the trunk of coconuts in the Bismarcks and adjoining groups. Chief of these are a large Rhinoceros beetle *Oryctes preussi* and the Elephant beetle *Xylotrupes nimrod*, Voet., while *Eurytrachelus pilosipes*, Waterhouse, and *Trichogomphus semilinki*, Ritz,are also offenders. In Samoa the Ceylon Rhinoceros beetle *Oryctes rhinoceros*, Lind., has been intoduced some years ago in earth carrying rubber seedlings. This latter is a pest of the greatest importance, but the four former species in the Bismarcks are more serious in that their borings allow of the entrance of the Red Palm weevil *Rhynchophorus ferrugineus*, Oliver, which does more damage than they do themselves, and it is probable that they are under control by certain *Scoliidæ* (parasitic wasps).

The method of dealing with all of these pests is to send small boys out in the early morning, who climb the trees and collect the beetles by hand, being paid so much per dozen. In Samoa trap mounds in which eggs, larvæ and beetles are collected have been found very helpful.

The Red Palm weevil, *Rhyncophorus ferrugineus*, is probably the most serious pest to coconut growers in the East and as far in this direction as the Solomons. It is a large beetle $1\frac{1}{2}$–$1\frac{3}{4}$ inches long, dark red to black in colour, which enters the trunks of the trees through a wound, or following on the borings of the beetles mentioned above. Laying its eggs in the wound, the grubs, when they hatch, feed on the heart of the tree, which finally snaps off. Treatment is by hand collecting, and the natives get very quick at detecting the presence of the pest, which is ascertained by listening to the sound of their feeding inside the trunk of the tree. The wound is then opened up and beetles and grubs collected and destroyed.

Another weevil *Sparagnobasis subcruciatus*, Mshl., attacks the bases of the trunks in New Guinea. The only external sign is a slight bleeding within about 2 feet of the ground, but internally the wood is found to be discoloured and penetrated through and through by the borings of the larvæ of this beetle, amongst which a few adults occur. The trees are weakened at the point of attack and soon break off and fall to the ground. The beetle, which is very like the banana borer but slightly larger, seems to travel by crawling and to have much the same habits as the banana beetle. I tried traps consisting of pieces of coconut wood laid on the ground with much success.

Insects attacking the Leaves in Fiji.

A large number of insects of various groups are found upon the leaves of the coconut, including some of the most important of its pests. The destruction of the foliage in some cases being carried to such an extent as to reduce the yield of nuts to a negligible quantity.

Coleoptera.

The only beetle attacking the leaves of coconuts in Fiji is the Hispid *Promecotheca reichei*. This beetle lays its egg on the under side of the leaf and covers it with a lump of excreta consisting of fragments of leaf. The grub, when it hatches, bores into and feeds between the two surfaces of the leaves. The portion of the leaf destroyed by the mining of the grub turns brown, and when fully matured there is a long brown patch 6 or 8 inches long and about $\frac{1}{8}$ inch wide at the base and $\frac{3}{4}$ inch at the apex. The adult beetle is a rather brightly coloured insect $\frac{3}{8}$ inch long with orange head, thorax and front half of elytra and steel blue anal half.

A pretty little yellow *Chalcid* wasp, as yet undescribed, a species of *Chætostricha*, destroys large numbers of eggs, whilst a larger blue-black species, an *Elasmus*, attacks the larvæ in their early stages.

Orthoptera.

The stick insect *Lepaphus cocophagus* is often very bad in parts of Fiji, eating the leaves in a notched manner. Smoke fires cause these insects to drop to the ground where numbers are destroyed by the fires.

Lepidoptera.

Zygænidæ.—To this group belongs the pest *Levuana iridescens*, Beth., Bak. the small purple moth, the larvæ of which are so destructive to coconut, royal, areca, fan, sago and other palms in Vitilevu. So far as is previously known, this insect has only been found on this one island in Fiji, but has spread to Malolo, Beqa and Ovalau within the past five years. It is at present unknown from any other part of the world. The eggs, which are oval in shape, are laid in clusters; they are greenish white at first and turn pink before hatching. The larva is white and slug-like with a few short spines and a black line along the sides. It feeds on the undersides of the leaves, eating the tissue in straight lines the width of its own body, and leaving the thin upper epidermis of the leaves, which turns brown. The fully-fed larva spins a flat white cocoon generally at the base of the leaves, but sometimes underneath the leaflets. It has a habit of attacking the tallest trees first and generally confines itself to two or three trees at first until it has completely destroyed their foliage, when it spreads to the surrounding ones in turn.

No internal parasites are known, but spiders and bugs, and other predators have been observed destroying the larvæ with, however, small effect. The attacks die out after a time to reappear perhaps a year later. No fungus or bacterial disease has yet been identified.

Coleophoridæ.—The larva of another moth, *Agonoxena argaula*, Meyr., eats the leaves in a similar manner to *Levuana iridescens* in Fiji, Wallis and Futuna, and Samoa. Whilst allied species occur in the islands to the northwest. The larva of this species is pale yellowish green, very slender in shape, and forms a web under which it lives and feeds. When disturbed it moves rapidly backwards and forwards, or drops to the ground. It pupates within a white silken cocoon placed along the mid-rib of the leaf, or more frequently drops to the ground and places it upon some low herbage. The moth is very flat in shape, pale yellow with darker lines, and a silver stripe showing along the back and across the end of the wings when at rest. Large numbers of the larvæ are found to be parasitised by two species of *Hymenoptera*, a *Chalcid* and a *Braconid*.

Rhynchota.

To this group belong the scales and mealy bugs which derive their nourishment by sucking the juices from the tree. Several are known from Fiji, but the only one of a serious nature at present is *Aspidiotus destructor*, Sign., the transparent coconut scale. This destructive pest is steadily extending its range within the group, carried by natives on coconut baskets, bananas and yaqona despite the utmost efforts of the Department. The attack shows as a yellow incrustation on the undersides of the leaves, whilst owing to the destruction of the green colouring matter the upper surface shows yellow in patches where the attack occurs. The female insect can be observed by lifting the scale covering with a pin as a heart-shaped body of a clear canary-yellow colour. Spraying with lime and sulphur was used for

some years against this pest. In consequence, however, of its continued spread, a mission was undertaken by the writer to the Society Islands, and the two parasites *Aspidiotiphagus citrinus* and *Aphelinus chrysomphali* successfully introduced with very gratifying results.

Other scales found on coconuts in Fiji, where they do little harm, are *Aspidiotus pangoensis*, Doane-Ferris, *Aspidiotus palmæ*, Ckll., *Aspidiotus simmondsi*, Green & Laing, *Chrysomphalus dictyospermi*, Morg., *Hemichionaspis minor*, Mshl., *Pinnaspis buxi*, Bouche, and *Pseudococcus cocotis*, Mar.

Insects attacking Leaves beyond Fiji.

Coleoptera.

The leaf destroying beetles *Promecotheca antigua* and *P. opacicollis* occur in the Bismarcks and New Hebrides respectively as major pests of coconuts with similar habits to the Fijian *P. reichei* which they much resemble. Like the latter they are subject to parasitic attacks, but *P. antigua* also suffers from a fungus disease in New Britain whilst a *Pentatomid* bug, an undescribed species of *Amyotea*, seems to habitually prey upon it.

Brontispa froggatti, Sharp.—This beetle lives in all stages in the unopened fronds. It is exceedingly flattened, with reddish-brown head, thorax and front of elytra, and black for the remainder of the elytra. The larva is also flattened to enable it to get down into its feeding places. Leaves of attacked trees open with patches of discolouration showing where the larva has fed and fine lines of brown caused by the nibbling of the adult. In the Solomons labour is employed climbing the trees collecting the beetle and pouring lead arsenate down into the unopened portion. In the Bismarkcs and New Hebrides it is the young trees which chiefly suffer. These, however, it frequently kills. Of natural enemies an earwig which lives in the same position is the only probable one known.

Orthoptera.

Tettigoniidæ.—A fine locustid of the genus *Habetia*, apparently undescribed, completely defoliates coconuts in parts of New Britain. Digging the soil over is the remedy employed, and this probably disturbs the eggs, and thus enables birds and other enemies to destroy them.

Lepidoptera.

Hesperidæ.—In the Solomons the larvæ of the skipper *Corone palmarum*, Moore, were found completely defoliating the palms on one estate in Ysabel. The larva cuts the leaflet half across, and folds it over, forming a pocket within which it lives, and feeds, and eventually pupates. As one leaflet is destroyed it moves to another. It is subject to at least three parasites, *Chalcis salomonis*, Cam., *Echthromorpha pallidilineata*, Cam., and most commonly a *Tachinid*, a species of *Blepharipoda* apparently undescribed.

Coleophoridæ.—The larvæ of a moth. *Agonoxena pyrogramma*, Meyr. occurs in the Solomons eating the leaves, in the same manner as *A. argaula* in Fiji. It differs from this latter in its brighter yellow colour and the absence of the silver strips along the back, and is subject to parasitic attacks in the same way as *Argaula*. This or an allied species occurs in the New Hebrides on sago only.

Pyralidæ.—The larva of another moth, a species of *Cryptoblades* near *Plagioleuca*, Turn., does much damage in Tahiti, feding under a web in the same manner as the last. An undescribed *Chalcid* parasite was found by the writer.

A *Tineid* moth *Hectacma indicatrix*, Meyr., and a *Lyonetiid* named *Decadarchis euophthalma*, Meyr., both new species discovered by the writer damaging coconuts by drawing the leaves together and feeding on them in the Solomons, whilst *Decadarchis psammaula*, Meyr., also new, was found behaving somewhat similarly in the Society Islands. The damage done by these last three species is trifling.

Rhynchota.

A hopper which has been named *Euryphlepsia cocos*, Muir., attacks the leaves in Guadalcanal, but is subject itself to destruction by fungus. It is at times a pest of major importance. Several additional scale insects are present in the North-Western Islands not yet recorded for Fiji. Chief of these are: *Aulacaspis cinnamoni*, Newt., *Aspidiotus aurantii*, both New Hebrides, *A cyanophylli*, Sig., *Pseudococcus simmondsi*, Laing, from New Britain, also the fringed Aphis *Cerataphis lataniæ*, Bois., from the same country, whilst *Lecanium tassellatum*, Sig., and *Platylecanium cocotis*, Laing, occur in the New Hebrides.

Insects attacking Unopened Spathe in Fiji.

Lepidoptera.

Cossidæ.—The larva of a large moth. *Acritocera negligens* does much damage in Fiji boring through the flower buds in the unopened spathe. The eggs are white, oval and about 1 m.m. in length, and appear to be generally laid at the bases of the leaves, whence the young larvæ make their way to the spathe, which they enter making an almost invisable spot, which, however, shows distinctly on the inside. The larva, which is white and beetle-like in form, has yellow mandibles and thoracic shield with a hard pointed anal segment of the same colour. The frass is also beetle-like and quite unlike that of the usual moth larva. When full fed is is nearly 2 inches long, and it makes a round hole near the apex of the spathe, and emerging drops to the ground and pupates. The cocoon is of earth and hard. Just prior to emerging, the pupa cuts an opening in the cocoon and works its way by means of setæ to the surface.

The male moth flies with great rapidity, and pairing must take place at once, as the female commences to oviposit frequently on the night it emerges. The perfect insect has the front wings brown with a wainscot effect of paler markings and a conspicuous transverse pale line two-thirds along from the base. The hind wings are almost white. The antennæ are highly pectinated. Both sexes of this moth are attracted to light and could be destroyed in some numbers in this way, whilst spraying the spathes with lead arsenate where possible would help. The moth probably causes more loss in Fiji than any other pest.

Pyralidæ.—Another moth larva often found in spathes is that of *Tirathaba trichogramma*. It is of a dull lead colour, and about $1\frac{1}{4}$ inches long when full fed. It has a habit of moving rapidly backwards or forwards. So far as I have observed this moth is only found in spathes previously damaged from some other cause, but it makes a fearful mess of these. It also attacks young nuts at the base and causes them to drop off. The larva spins a cocoon in the old spathe or nut or in rubbish at the bases of the leaves. The moth is about 1 inch across, pale-brown front wings and very pale hind wings with a pearly lustre. Like the preceding it is attracted to light.

Insects attacking Spathes beyond Fiji.

Lepidoptera.

Tineidæ.—Throughout the Solomons and New Hebrides the larvæ of a very minute moth *Batrachedra arenosella*, Wa., is found in large numbers in the unopened spathes. The presence of the larvæ can frequently be detected by gumming at the points of entry, whilst the writer counted over, 240 such punctures in one spathe. When full fed the larva is about $\frac{3}{8}$ inch long, almost white, with a yellow head and black mark in first segment. It spins a silk cocoon covered with reddish frass either along the stem of the flower or inside a male flower which it has eaten out, and from which it always projects slightly. The moth has pale yellowish wings slightly speckled with black, and very long dark fringes. It is a well known pest in Malaya also.

Pyralidæ.—The larvæ of the moth *Tirathaba rufivena*, Wall, attack flower spathes in the Solomons and Bismarks in the same way that *T. trichogramma* does in Fiji and Tonga.

Insects attacking Flowers.

In Fiji no insects are recorded as attacking the flowers of coconuts, but throughout the New Hebrides, Solomons and to New Guinea a bug, *Axiagastus cambelli*, Dist., is in great numbers, whilst several *Cetonidæ*, some of brilliant colours, feed upon the pollen. They doubtless do damage by wounding in the case of the bug and destroying pollen in the case of the beetles, although the latter may also assist in fertilising to some extent.

Insects attacking Nuts.

Diptera.

Ortalidæ.—The larvæ of a fly *Scholastes bimaculatus*, Hend., is often found in ripe nuts which have lain in the ground for some time, and which they turn into a foul smelling seething mass of slime. The fly probably lays its eggs on nuts which have lost their calyx in falling, and the maggots enter by the eye.

S. lonchifora, Hend., has similar habits in the Cook Islands, and there is another species present in Samoa.

Coleoptera.

The adults of a large beetle, a species of Rhinoceros beetle, *Papuana lævipennis*, Arr., destroy seedling nuts in the Solomons by boring through the coir and eventually destroying the young shoot. This beetle is said to breed in taro.

Fungus and Bacterial Disease.

In addition to the above there are a number of fungus-bacterial diseases known to attack coconuts. Chief of these in Fiji is Bud-rot, whilst it is probable that nematode worms also occasion nut fall and rots at times. These matters however lie outside the scope of the present paper.

Note.—With the exceptions of the *Eurytræhelus*, *Xylotrupes*, *Trichogomphus*, *Oryctes*, *Calandra*, three species of *Promecotheca*, *Tirathaba*, *Lepaphus*, *Axiagastus* and *Aspidiotus destructor*, the whole of the other species were kindly identified for me by the Imperial Bureau of Entomology.

RICE INDUSTRY IN FIJI.

By J. P. TARBY, Manager, Government Rice Mill.

Among the various industries in Fiji, the Rice Industry holds out the most sound inducement for investment of capital and the greatest promise for expansion. It yields quick returns; it is practically unaffected by hurricanes and floods; it is at present free from diseases and pests; and the general local conditions are so favourable that it is capable of being extended to many parts of the group.

Moreover, the geographical position of the Colony; the suitability of its climate and the fertility of its soil; the many waterways between its islands, besides many other advantages, not the least of which is the large population of East Indians, are factors conducive to the successful cultivation and manufacture of rice. Indeed, properly capitalised and organised the industry should prove, before long, second only to sugar and vie with it for first place in economic value and importance.

Further, the adjacent markets of Australia, New Zealand and of the many groups of islands south of the Equator, not only offer large and increasing outlets for the Fiji product but specially invite its production.

A great factor in support of this is the Colony's geographical position. It should also form the basis of a policy to make Fiji the rice market of the South Seas. There is plenty of suitable land in the Colony, and the surrounding islands, exclusive of Australia and New Guinea, would appear to offer markets for 10,000 tons of rice per annum, but the essential requisites, capital, organisation and co-operation for its accomplishment must first be assured.

While this enviable central position does not materially benefit such industries as copra, cotton and rubber, which have to be exported to far away countries, it has a direct beneficial bearing on those of sugar, bananas and rice, which find ready markets at Fiji's very door, as it were.

Of the latter products, however, the rice industry calls for special attention, as rice is the staple food of many thousands and the part ration of very many more thousands in the South Seas, and it has to be brought from countries thousands of miles away in the middle and far East.

A suggestion has been made that beyond making Fiji self-supporting in rice there is no need for further expansion, that is, exportation. Such a policy would certainly be opposed to progress.

Exception has even also been taken to the rice industry for the supply of local demands on the ground of its interference with the labour supply in the Colony. I dispute the contention that the industry, in its legitimate function, has interfered to any extent with vested interests.

Even when the industry is expanded for the purpose of export in large quantities, which can only be made possible by the supplementation of hand-labour by implements such as tractors, drills, reaping and threshing machines, &c., then larger areas will have to be put under rice, but the objective, in the use of implements and machines, being expansive, cheaper and greater production per caput, no greater call upon the labour supply of the Colony need be anticipated.

For comparison sake, allowing that its interference with vested agricultural interests has been greater than is apparent, have there not been compensating offsets to the planting community and the Colony generally? Take for instance the year 1921, during the first half of which the Government Rice Mill turned out and sold 408 tons of rice at £23 per ton, whilst the oversea article in Australia, New Zealand and the Islands was selling at prices

ranging from £40 to £70 per ton. Compare this with the previous year, 1920, during the first half of which, owing to great scarcity of oversea rice, the Government was forced to import 500 tons at the cost of about £50 per ton and distribute it to merchants at £23 per ton for retail at £28 per ton, thereby incurring a loss of public funds of many thousands of pounds.

Consider also the fact that since July last, in spite of the increased duty, imagined by some to have been put on to protect the rice mill, the mill has been supplying the Colony with rice, the most of the time, at prices from 10s. to £1 per ton less than, and lately, equal to the landed cost of oversea rice, exclusive of any duty. That is, based on the old duty of £2 per ton, it has been sold at prices of from £2 to £3 per ton less than the imported article. From last July to the end of next month (June) no less than 1,300 tons will have been sold on those terms.

Bear in mind, also, the benefit arising out of the by-product of the mill, that is, " rice-bran," of which 120 tons at least will have been sold this year by the end of next month. According to well-known authorities, and an analysis made here by the Government Analyst, its feeding value is within 1 to 3 per cent. of that of wheat bran, and yet its price is about one-quarter to one third that of the latter.

The economic value of the rice industry in the Colony must not be gauged by the foregoing only, not even by the present output of the Government Rice Mill, as the bulk of the rice consumed by the Indians in the country districts is hand-milled. Owing, however, to lack of proper agricultural returns in the past, a true estimate of the amount produced and consumed in the Colony cannot be arrived at, but, based on conservative figures, the total output of clean rice would appear to be from 9,000 to 10,000 tons per annum of an economic value of from £180,000 to £200,000. Compared with other principal agricultural and manufacturing industries it ranks third in economic value, while it is, at present, in excess of the banana industry.

In economic importance, besides, it also ranks high, as not only does it render the Colony self-supporting in the most essential and indispensable staple food for all classes, more especially the East Indians, and native Fijians and other labouring and working classes employed on plantations, &c., but it ensures a reliable and cheaper supply of the principal, if not the very article of, food on the cost of which depends, and is based, the wage of the labouring classes.

This is a very important point and one calling for the fullest co-operation with the rice mill, as the more it is patronised the greater its output, and the cheaper still the price of rice. It is simply a question of spreading overhead costs over larger outputs. Indeed, with the introduction of heavy cropping varieties of rice and the use of implements, &c., to cheapen cost of cultivation, to compensate the grower against a lesser price still for his paddy, it is safe to predict that the time would not be far distant when the price of rice at the mill might yet be as low as £15 per ton. This, however, can only be made possible with co-operation.

But in view of the encouragement given by most of the sugar companies, some planters and certain merchants, who trade in it, to the evil practice of hand-milling of rice by the Indians, by purchasing it in preference to the machine-milled article, because it is a little cheaper, it is questionable if this desideratum will ever be reached, in fact, it is not improbable, if the practice continues and increases, as it must, that the mill will be forced to close down and the Colony be driven to rely on imported rice for its supplies during several months of each year, whilst the labour supply and the industry are threatened with extinction.

To make this clear, it should be stated that it requires the labour of from 30 to 40 units to hand-mill one ton of rice, the mill needs 2, and another 5 to 10 units to hawk and sell it, so that for every ton of such rice bought by the planting community and the public, no less than 35 to 50 units are kept away from the labour market or from further production on the land. The amount of this labour wastage becomes very apparent, even at this early stage, when it is considered that some 1,000 to 1,500 tons of such rice were sold last year, thereby locking up the labour of no less than from 35,000 to 75,000 units, whereas the same quantity of rice treated at the mill would require not more than 2,000 to 3,000 units.

Every credit is due to the East Indians for the existence of the rice industry. They very wisely began it and brought it to what it is now; they are, therefore, deserving of much help and assistance to further their gains and the industry, but, in the right way, that is, to produce more and cheaper crops on their own lands or those of others.

The " Dheki " (foot-mill) is as indispensable to the Indian settler as are his cooking utensils, and its use for cleaning his rice for home consumption is pardonable and unavoidable. Its further use for commercial purposes, however, should not only be discouraged but every endeavour should be made to restrict the use of it in that way, as by so doing the interests of other agricultural industries are jeopardised.

Strange to say, the very companies and planters who complain that the scarcity of labour is materially retarding the progress of their respective industries are the very ones to encourage this labour-wasting and anti-production practice.

The cultivation of rice is still entirely in the hands of East Indians whose methods of cultivation, &c., are primitive, costly and even wasteful. Through neglect and non-selection of seed the principal varieties—Patna, Chaetwa, Motka—have become mixed, and their essential qualities impaired, so that not only have the Fiji paddies become difficult to treat at the mill, but smaller yields per acre are obtained.

With the view of overcoming this, seeds of new heavy-cropping varieties have already been imported from the Philippines, and others are expected from America and Japan. During the coming planting season they will be planted out in nurseries under official supervision, and issued out next year to the various rice growing districts.

While this is an excellent move in the right direction it is greatly to be hoped that it will soon be followed by the use of proper implements and machines in the field, as only under such conditions can the industry be made to prosper and become remunerative to both producer and consumer.

The same idea seems prevalent about rice growing with implements as there was about rice milling in Fiji, viz., that it could not be made a commercial success. As the latter was disproved, so assuredly will the former be. Indeed, so possible is it, that as soon as an example is set Europeans will adopt it, and find it a profitable occupation. Then and only then will the rice industry be established on a sound basis, capable of great expansion.

But, as implements and machines are costly and cannot be owned by each small grower separately, it will be necessary, after rice growing by implements, &c., has been successfully demonstrated, that the industry under the new conditions should be started under proper organisation.

The Government Rice Mill has been a plodding and silent worker, and, thanks to the valuable support given to it by most of the merchants, certain

planters and the general public, not only has it surmounted many obstacles, but is has proved to be, as far as circumstances have allowed, a commercial success.

The quality of the rice exported to various islands, as far even as Tahiti and New Zealand, has given such satisfaction that it warrants the hope that an export trade, under the new conditions above stated, will be profitable and easy of accomplishment.

CO-OPERATION AMONGST BANANA PLANTERS AND SHIPPERS.

By E. S. Gordon, Inspector of Produce.

Co-operation is not only of vital importance to all our industries but also to individuals, and is wanted more in Fiji at the present moment than almost anything else.

As the banana industry is the branch which comes directly within my sphere of work and is also of great importance to the Colony I will confine my remarks to it as a whole.

At present it is in anything but a satisfactory condition, and although this state of affairs has been brought about by many indirect causes, the principal one, in my opinion, is the lack of co-operation amongst the banana growers and buyers.

The banana community in Fiji is composed of two factions, the grower and the buyer, but unfortunately the former is very much in the minority.

I would point out that even when the industry was at its best, in 1916, the control of the banana rested with the buyer and not with the legitimate grower, the consequence being that we are dependent purely on the native rather than the European as a producer.

There have been many set backs to the industry, such as the closing of the Australian market, strikes, even hurricanes, &c., which has not been conducive to banana growing by Europeans, but at the same time if the buyer had been a producer even in a small way I feel sure that the industry would be in a very much better footing now.

The native, as is well known, is not a very responsible person at best, but owing to the eccentricities or shall I say the peculiarities of the European purchaser has become a most unreliable producer.

At present I regret to state there seems to be a mutual distrust amongst the European shippers and consequently between the native grower and purchaser, and which is doing much harm to the industry.

The only way to overcome this difficulty is by a co-operative scheme which can be productive of much good and the sooner this is accomplished the readier would the Government be to support such a scheme.

At present there is no system whatever amongst the European purchasers, but only a frenzied idea to secure fruit for the individual without thought or consideration to the industry generally.

By means of a co-operative scheme thousands of pounds could be saved by doing away with unnecessary transport and labour. Besides, satisfactory and payable prices could be fixed for both the grower and purchaser.

I do not intend going fully into the pros and cons of the case as this is a question for the growers and shippers to decide and these notes are written in order to form some basis for a discussion between the many interested parties, who will be present during Fleet Week.

There is a possibility of our entering into a banana export to Canada and also a renewal of trade with Australia, when only a thorough co-operative scheme will make either the one market, or the other, a success.

If we are to make a success of the banana industry in the the future and give it the place it deserves among the other industries, large areas in new districts will have to be opened up and new and up to date methods, both as regards cultivation and handling, adopted.

There are many difficulties to be overcome such as the combating of disease and pest and the only help in this matter will be by the close co-operation between the settlers and the Agricultural Department of this Colony.

At present Mr. Campbell, the Government Mycologist who has only just arrived in the Colony and has seen a good deal of this island during a tour with myself through the main districts, is investigating the so-called "Sigatoka disease" and I hope before long he may be able to give some definite information abour same.

In conclusion I sincerely trust that the coming meetings will only be the forerunner of others, as this is the only proper way to bring about co-operation for the general benefit of all interested in the Colony.

Our "slogan" in the future should be co-operation in all industries and consequently advancement of the Colony as a whole.

IMPORTATION OF GRASS SEEDS, ETC.

The attention of planters and others is drawn to the Regulations governing the importation of seeds, live stems and whole plants of pasture and fodder grasses into the Colony. That such importations are governed by Regulations is not widely known and there have, in consequence, been cases in which seeds have been destroyed for non-compliance with Regulations. The Department therefore desires to make the following information widely known:—

A Proclamation made under the Diseases of Plants Ordinance 1913 (Proclamation No. 8 of 1922)—

(*a*) Prohibits the importation of all seeds, live stems and whole plants of pasture and fodder grasses except under a written permit first obtained from the Superintendent of Agriculture. This prohibition does not extend to seeds, &c., of Para grass, Guinea grass and Paspalum species imported from countries other than Australia and New Zealand;

(*b*) prohibits the importation of all grass seeds from Australia and New Zealand unless accompanied by a certificate signed by a responsible officer of the Department of Agriculture of the country where the grass was grown certifying that the district in which it was produced is entirely free from cattle tick infestation.

(*a*) Is provided in order to enable the Department of Agriculture to stop importations of undesirable grasses.

(*b*) Is self explanatory.

The Department will be glad if all persons interested will make the above information widely known.

IMPORTATION OF COTTON SEEDS, ETC.

By a Proclamation (No. 10 of 1922) made under the Diseases of Plants Ordinance 1913 the importation of cotton seeds, seed cotton and ginned cotton is prohibited except under a written permit first obtained from the Superintendent of Agriculture. This Proclamation was enacted with a view to preventing the introduction of diseases, pests and of undesirable types of cotton seed.

2. Before permits will be issued in the future the Department requires in the case of Australia, written guarantees from either the British-Australian Cotton Growing Association, the Director of Cotton Culture, Queensland, or the Directors of Agriculture in other States stating:—

(*a*) the variety of the seed;
(*b*) that the seed is of a pure strain;
(*c*) that the seed is free from disease.

The guarantees referred to above should be submitted with the application for a permit to import and *before* the seed is ordered.

Compliance with these notes will prevent loss through destruction of seeds.

COTTON INSECT PESTS RECORDED IN FIJI.

By H. W. Simmonds, F.E.S., Acting Government Entomologist.

In view of the renewed interest in the cultivation of cotton, the following list and notes on insects found affecting cotton in Fiji has been drawn up by the Government Entomologist. It will be seen that Fiji when compared with other cotton-producing countries is singularly free from many of the serious diseases which affect the growth of the plant or the yield in cotton in other countries, and every reasonable precaution is taken to maintain it so.—ED.

LEPIDOTERA.

Earias fabia (tip worm).—Possibly most serious pest in Fiji, although easily suppressed by pinching off early the affected branch tips on appearance of the first brood.

Gelechia gossypiella, Saund. (Pink Boll worm).

Anomis flava.—Scarce and probably only destroys few leaves.

Stathmopoda trichrysa, Meyr.

Hieroxestis aurisquamosa, But.

Pyroderces euryspora, Meyr. (new species).

Stathmopoda synchrysa, Meyr. (new species).

Labdia opisona, Meyr.

L. calida, Meyr.

L. allotropa, Meyr. (new species).

Decadarchis heterogramma, Meyr.

Limœcia inconcinna, Meyr.

All the last nine are probably harmless rubbish feeders, only attacking damaged cotton.

RHYNCHOTA.

Dysdercus insularis and *D. impictiventris* (Cotton stainers).—I have only met the first of these two on cotton, but it is numerous at times.

Tectocoris lineola Shield bug).—Common at times and generally accompanied by many rotton cotton bolls. It is a major pest.

Saissetia (*lecanium*) *nigra*, Nietn.—This scale is not uncommon.

Hemichionaspis minor, Mash.—This has been found on cotton at Labasa.

A mealy bug, probably *Pseudococcus virgatus*, but identification not confirmed, occurs.

Aphis gossypii does damage to young plants only.

COLEOPTERA.

A new species of *Scolytidæ* named *Hypothenemus gossypii*, Samp., was found feeding in damaged cotton seeds.

It will be observed that Fiji is singularly free from serious disease. The tip worm (*Earias fabia*) is easily controlled, and the pink boll worm (*Gelechia*

gossypiella) has done little damage. *Dysdercus* and *Tectocoris* do damage chiefly by allowing fungus spores to enter by the wounds they make in sucking, and the clearing up and burning of all cotton plants every year, with a gap before replanting, and the destruction of alternative host plants, will do much to control these pests. *Dysdercus* can also be trapped by means of cotton seed placed in lumps about the estate, and then collected and scalded daily. Such serious pests as the boll weevil of America, and *Monolepta* beetles of Australia, are fortunately unknown in Fiji, and even the world-wide *Heliothris obsoleta* does not seem to occur in these islands.*

* Since the above was written a moth bred from a larva found attacking tomatoes at Levuka has been identified as *Heliothris obcoleta F.*

AMERICAN COTTON YIELDS PER ACRE.

It is interesting to note that Tennessee ranks fifth among the lint cotton producing States in yield of cotton per acre. Missouri stands far in the lead of all States, while Texas, the state that produces nearly as much as all the others combined, is tenth in the per acre yield. Following are the yields by States for 1922:—

	lb
Missouri	325
North Carolina	250
Virginia	225
California	200
Arizona	200
Tennessee	190
Arkansas	175
Mississippi	157
Louisiana	152
Alabama	144
Texas	130
South Carolina	123
Oklahoma	103
Georgia	100
Florida	97

The yield in Missouri was practically as much per acre as the combined per acre yield of South Carolina, Oklahoma and Georgia. The average yield of lint cotton per acre for the United States was 141·6 lb.—*Cotton Association News*, Arkansas.

COTTON CROP IN QUEENSLAND.

It is expected that this year's cotton crop in Queensland will represent a value of about £750,000. About 62,000 acres are under crop, which is more than double last season's area. The average return per acre on the above figures would represent £12 3s. gross.

FIJI SEA ISLAND COTTON.

Following a cablegram received from the Crown Agents on the 31st May last, referring to the sale of the consignment of 101 bales of Sea Island Cotton shipped direct to Liverpool in December last, account sales have been received by the Department of Agriculture stating that the samples have been examined and reporting on the nominal value and the price realised as follows:—

Bales.	*Nominal value.*	*Price sold per* ℔.	
1	27d. to 28d.	27d.	Clean, bright, staple good length and strong, moderately fine.
11	26d.	26d.	Clean and bright, staple fairly strong but wanting in fineness, rather irregular in length.
53	24d.	25d.	Bright, staple moderately fine, irregular in length rather weak.
26	22d. to 23d.	23½d.	Bright, slightly spotted with stain, staple moderate length, rather lacking in fineness and length.
11	20d.	22d.	Generally rather stained staple, staple wanting in fineness and weak.

The gross return of the crop realised 2s. 1d. per ℔ of lint sold which may be considered very satisfactory indeed and represents a net return to the grower of 5d. per ℔ of seed cotton delivered at the ginnery. The out-turn was 25·8 per cent. of lint to seed cotton, it thereofre required approximately four pounds of seed cotton to gin one pound of lint.

Although the price realised by the cotton is quite satisfactory, it is evident from reading the report of the critical examination submitted by the British Cotton Growers Association, that greater care in picking and better cultivation and attention to damage caused by pests would have resulted in another 3d. to 6d. being realised by a good deal of the cotton which shows irregularity in length, lack in strength and spots and stains, all indicating careless cultivation and defects which long experience and methodical organisation have eliminated from West Indian Sea Island Cotton.

THE COTTON TIP WORM.

(*Earias sp.* and *huegeli.*)

The larvae of this small moth proved one of the most troublesome of all pests which attacked the cotton crop last year, but they were easily checked.

The moth lays its eggs singly on the tender growth of the cotton bush and the resulting larvae or caterpillars gnaw into the soft tip wood for two weeks or so, hence the name "tip worm." After feeding on the pith of the young wood, especially at the base of the shoots, it pupates and turns into a moth which lays eggs again. This second brood synchronising with the time the squares form, the larvæ mine into the bolls, penetrate the seeds and cut the lint.

As they were timely detected, the cutting and destroying of the affected tender shoots checked the pest, the plants at the end of the picking season were burned, allowing the growers to plough the ground.

COTTON-SEED MEAL.

Weight for weight, the feeding value of cotton-seed meal is equivalent to that of linseed meal. This fact has been recognised for the last three or four decades, and with stock owners the use of it resolves itself into one of cost. The test at Gatton College in Queensland when by scientific feeding the milk yield of cows increased 35 per cent. confirms this fact. When the respective price of linseed meal, £12 per ton, and cotton-seed meal, £7 per ton, are compared, it is seen that Fijian dairymen have now available a cheap and valuable feeding stuff. When combined with rice bran sold by the Government Rice Mill at 5s. per cwt. bag, delivered anywhere in Suva, or at £4 per ton, whereas imported wheat bran of equal feeding value sells for £12 a ton it is clearly a sound business proposition by combining the two kinds of meal to increase the milk yield from Para grass fed cows by at least 20 to 30 per cent.

THE OIL PALM (ELAEIS GUINEAENSIS).

The ravages caused by the purple coconut palm moth *Levuana iridescens*, Beth., Baker, to the plantations on Vitilevu have to all intents and purposes, for the present at any rate, removed copra from the list of exports from the main islands of the Fiji Group.

Within the last few years the pest has been carried to a few adjoining islands and islets, the chief of these, Ovalau, with the town of Levuka as the centre, whence interisland cutters start for the Lau islands, Lomaiviti and for Vanualevu, Taveuni and others dependent at present on the copra industry. The rapid spread of the pest has of late been so alarming that at last efforts are being made to check and to control the cause.

Where individual or small clumps of the fan or of the coconut palms are attacked, it is quite possible to deal with the leaf-eating grub by ordinary methods of spraying well known to gardeners and to orchardists. Where, however, the problem to be faced consists in keeping free thousands of trees growing in thick clusters, extending from the sea beach to steep mountain sides, over broken country too rough for wheels or sledges, where the height of the coconut trees reaches 50 feet to 70 feet, there the climbing up the stems with spray pumps is too laborious and the cost of using a power sprayer with extension rods, although theoretically apparently feasible, becomes an impractical proposition.

The welfare of Fiji is too closely linked up with that of the copra industry to wait until means have been proved successful for controlling the pest at a cost that the industry can afford to pay. Any measure therefore that can ensure a continuity of profitable production is worth trying.

The following notes on the Oil Palm, based on returns of Sumatra plantations, are mainly taken from the *Bulletin of the Imperial Institute*, Vol. XVIII, No. 2, 1920.

Natural conditions.—The range of country suitable for Oil Palm is more extensive than that the coconut prefers. Distance from the sea coast and altitude do not affect it as they do the coconut, provided the land be rich, the rainfall ample, and the climate warm and moist. As these natural conditions are features of portions of the larger islands of the Fiji Group, the Oil Palm would add to rather than interfere with copra production.

Another consideration in its favour is that whereas the Levuana moth grubs attack the leaves of the coconut, of the Royal and Sago Palms, the Oil Palms growing amongst them seem only slightly affected and at all events,

on account of their smaller size, they can readily be sprayed and kept clean of the pest.

For these considerations, I took steps soon after coming to Fiji to procure from reliable sources the best kinds of Oil Palm nuts available for planting, and through the good offices of the British Consul at Batavia, the Department of Agriculture has received a parcel of kernels. These are now available for distribution amongst planters in suitable localities.

Types.—Several types of Oil Palms are known—the thick shell type (*Macrocarya*), the ordinary *dura* type, the thin shelled *tenera*, and the shelless or *pisifera* type.

Of these the one so far almost exclusively planted in Sumatra, the Deli type, a good form of *E.G. dura*, is the one procured. Until a better form has been established by selection work, it is the same standard type which the few hundred acres planted, twelve years ago, when I looked over a small plantation, have since grown into 30,000 acres, established on nearly every kind of soil and at altitudes ranging from 30 to 1,500 feet.

Germination.—Germination is slow, ripe fruit, those hand-picked from the bunches, being the best; the fresher these are the quicker they germinate. Imported seed, best packed in a moist mixture of charcoal and sand or coated with paraffin wax and packed in paper or wood shavings, germinate slowly, only about 50 per cent. sprouting within nine months. To hasten germination it is recommended to keep the kernels for weeks in water brought up every day to a temperature of 104° F., when a germination of 60 to 80 per cent. may be expected within three or four months. The treated seeds are pushed into the prepared seed beds at intervals of 10 to 12 inches, the beds being 3 to 4 feet wide.

Planting and upkeep.—When the young palms are strong enough, 8 to 12 inches, they may be planted, preferably on sloping ground with contour ditches to catch the surface water and prevent soil erosion. Holes 20 to 24 inches square, half filled with mould, are prepared, spaced 30 feet, giving 48 trees to the acre on the square and 57 on the diamond shape system.

Cover crops of a suitable leguminous plants answering the double object of keeping down weeds and of fertilising the ground are recommended in preference to clean weeding. Interplanting with Robusta coffee is done on a large scale in Sumatra. Bananas, pineapples, ground nuts, or quick growing crops would answer equally well in Fiji, the resulting returns paying for the initial and the maintenance costs until such time as the trees bear fruit.

Pruning should be restricted to those leaves which it is necessary to remove for harvesting the bunches, but it should be done sparingly. Artificial pollination, as in the case of the date palm, increases the fruit crop, the pollen being collected from the male spikes in the afternoon, when the atmosphere is dry. To guard against mould attack, some quick-lime is placed in stoppered glass jars and a disc of cardboard placed over it. When applied that pollen is conveniently applied with a rubber pouch, as used for blowing pyrethrum powder over unfolding banana bunches for keeping them clean of the rust mite. A spraying flask or atomiser may also be used; one man in a working day can pollinate 500 to 1,000 trees if the inflorescence can be reached from the ground without the use of a ladder. The female spadices are borne on shorter stalks and grow into spherical masses 6 to 12 inches across. It carries a great number of nuts with the kernel inside. Six months generally elapse between pollination and the ripening of the fruit.

For the first 12 or 15 years an Oil Palm produces 20 to 24 leaves annually, and this affords a means of ascertaining by counting the butts of the leaf stalks the age of the trees.

Manuring.—Unless the leaves and the remains of the bunches and pulp are returned to the soil, the quantities of plant food extracted annually by an average crop amount to 1 cwt. nitrogen, 1½ cwt. potash, and ½ cwt. phosphoric acid.

Diseases.—The Oil Palm has so far proved more resistant to diseases than even the coconut. Young plants in Sumatra are subject to a disease which manifests itself by the leaf stalks becoming weak and bending over at about half their height and then falling off, but they ultimately recover. In other parts some fungoid diseases have been recorded, which are checked by spraying with Bordeaux mixture or by uprooting and burning on the spot and by disinfecting the dry hole where they stood with freshly-slaked lime.

Of insect pests several are common with the coconut palm, but the trees being shorter and more easily reached for treatment they are easier to check.

Harvesting.—Trees up to fifteen years carry their fruit within reach without having to carry short ladders to get at the bunches as on older trees. These ripen pretty well in the order the spathes emerge from the crown of the stem, but to save themselves the trouble of several climbs the natives cut four or five bunchy cones at the same time, some being over ripe and others barely ready to be cut. The result is a larger percentage of free fatty acid than would be the case had the fruit been picked at the proper time. The cones are brought to the factory, where, if bruised, they are treated as quickly as possible, the fleshy part of the nuts going through the depulping or depericarping and pressing processes.

Oil casks.—Containers present a difficulty in the distant countries which is not so marked in the case of the African Tropical Colonies where the same casks are returned empty and used over again. To overcome this difficulty a "bleaching" process which solidifies the fat is said to likely become a practicable proposition.

Yield.—From the fifth to the tenth year the annual yield of bunches per tree would average 10 to 12, weighing 12 lb to 14 lb, the total weight of the bunches being 158 lb, and that of the fruit 56 lb.

From the eleventh to the thirieth year the figure would be 10 bunches per tree, weighing 33 lb per bunch, or a total of 330 lb for 165 lb of fruit.

From the thirty-first to the fiftieth year the yield declines to 3 bunches of 44 lb, weighing 132 lb, yielding 66 lb of fruit.

The percentage of oil in the pulp and in the kernel is approximately 50 per cent. in each case, but the average per cent. of pulp is 60 and that of kernels 8, irrespective of whether the trees are young or old. With modern machinery it would be possible to extract 80 per cent. of the oil contained in the pulp and the whole of that in the kernels.

Compared with copra, and although the machinery for preparing the Oil Palm products is more costly than that needed for preparing the products of the coconut palm (copra and coir), it seems preferable in Sumatra to open up plantations of Oil palms, where conditions are favourable, than it does to extend coconut estates.

ESTABLISHMENT IN FIJI OF A PARASITE OF WHITE GRUBS.

By Robert Veitch, B.Sc., F.E.S., Entomologist to the Colonial Sugar Refining Company.

In December, 1917, the writer transported a large colony of a Scoliid wasp (*Scolia manilæ*, Ashm.) from Hawaii to Fiji in the hope that this white grub parasite would attack the white grubs in the soils of the sugar-cane

plantations of the latter country where they do very considerable damage to the roots of the cane crop and also to the base of the shoots of the younger crops which they sometimes totally destroy.

The parasites were liberated in the Sigatoka district, the actual spot chosen being the sandy flat at Cuvu which is always badly infested with white grubs of *Rhopaea vestita*, Arrow, and, to a lesser extent, with the grubs of *Adoretus versutus*, Har. A few weeks after liberation a serious and totally unexpected flood covered nearly the whole of this area for a few hours and as no trace of the parasite could be found during the ensuing twelve months it was feared that the colony had perished in the flood. However, on 12th June, 1922, the writer was surprised to find a male of this parasite at Dreketi, near Lautoka mill, showing clearly that the wasp is now permanently established.

The recovery of this parasite almost five years after the liberation of the colony is somewhat surprising and serves to illustrate the slow rate of progress in the permanent establishment of most parasites introduced to Fiji. The fact that it has now spread sixty miles from the spot at which it was first liberated is gratifying and leads to the belief that it is aiding the control of white grubs over a large area. The species of white grubs it is believed to be living on are *Rhopæa vestita*, Arrow, *Rhopæa subnitida*, Arrow (both Melolonthid beetles), and *Adoretus versutus*, Har. (a Rutelid beetle). It has actually been bred in captivity in Fiji from grubs of the last named species and it has also laid eggs on the first named species, these eggs hatching into larvæ which fed on their hosts for some time, but never reached maturity, as, unfortunately, both host and parasite were attacked and destroyed by mites. In Hawaii it functions as an excellent control factor of *Anomala orietalis*, Waterh., a white grub that was the cause of very extensive losses on two of the largest irrigated plantations on the island of Oahu.

COCONUT SPATHE BORER (ACRITOCERA NEGLIGENS).

By H. W. Simmonds, F.E.S., Acting Government Entomologist.

History.—This pest, which is one of the most serious affecting the yield of coconuts in Fiji, was first bred from affected spathes on Vuna Estate by Jepson.

Symptoms.—On walking through coconut estates in Fiji one often sees newly-opened spathes in which a large number of the flowers, both male and female, have been destroyed, and form an unsightly red stained mass. If the sheath of such spathes be examined, one or more holes, about 3/16th inch in diameter will be found near the apex. These represent the openings made by the exit of the larva of a moth which causes the damage. Closer examination of this sheath will show, on the outside, near its base, a tiny dark brown stain, and if one turns to the inside this is seen to be caused by a minute puncture, leading from which is a reddish line, which gradually develops into the tunnel of a boring larva, the tiny puncture marking the point where the young larva first penetrated the spike, as the larger hole at the apex marks its exit. The tunnel of the larva which first entered at the base of the spike proceeds towards the apex completely destroying all buds in which it comes in contact, and being filled with a mass of red sodden frass, such as is characteristic of beetle larvæ rather than that of a moth.

Cause.—If an attacked spathe be opened before they have made their exit one or more (I have found as many as nine) whitish or pinkish grubs will be found. These, when full grown, are about two inches long and so closely resemble beetle larvæ as to have deceived every entomologist who

has seen them at first. They have no pseudo legs and the anus terminates in a wide horny projection. The segments of this larva are very deeply indented. When full fed, the larva makes the opening at the apex, and, thence descends to earth, where it burrows a few inches, and there forms a cocoon of silk and pieces of soil, and pupates. The pupa is armed with rings of setæ on the abdominal segments. Shortly before it is ready to emerge it cuts a circular opening at the end of the cocoon, and by means of the setæ works its way to the surface of the ground, where it projects slightly, and emerges.

The moth.—The moth is dark brown in the front wings with pale linear markings, and a transverse pale line nearly parallel with the hind margin, about two-thirds of the way along the wing. The hind wings are almost white, whilst the antennæ are pectenated, highly so in the males.

Habits.—After emergence, immediately its wings are dry, the moth dashes wildly about, and pairing must take place at once, as the female commences to oviposit the same night that she emerges. Both sexes are attracted to light, and it is possible that light-traps may prove useful in its control.

Eggs.—The eggs are about 0/16th of an inch in length, pale yellow and oval in shape. Under a low glass they are seen to be faceted, and a small hair comes from each facet. They are laid in batches, and not singly as I had expected to find them. I had for long searched for the egg at the bases of the spathes unsuccessfully. When, however, a newly-emerged female commenced to oviposit in captivity in batches, I realised that they could not be placed on the spathes, but must be at some distance away. On showing them to two different Fijians both told me that they had seen such batches and that they were placed at the bases of the leaves. This means that the larva will have some distance to crawl before reaching the spike, and will account for many slight stains on the spike with no corresponding puncture, showing where the larva has nibbled before boring in.

Control.—In addition to the possible use of light traps I think that it would be well worth spraying the spathes of young trees with lead arsenate, which would probably reduce the percentage of infection considerably. It is also possible that the eggs will be found to be parasitised when discovered in the field.

Distribution.—The disease is probably present everywhere in Fiji, although on the island of Rabi I have found no trace.

Note.—The larva, pupa and egg of this insect are all highly abnormal, and have been sent to London, where a technical description will be published, the egg being newly discovered, whilst the larvæ and pupæ were unknown in London previous to those recently sent home.

(Since the above was written the writer has found the egg in the field laid as was anticipated at the bases of the leaves.)

BENEFICIAL LADYBIRDS.

By arrangement with the Department of Agriculture, Mr. A. M. Lea, the Entomologist from South Australia on loan to the Levuana Control Committee, forwarded to Suva advance colonies of useful ladybirds, and also brought with him further colonies in March last.

These consisted of *Orcus australasiæ* and *O. chalybeus*, both scale insect feeders; *Leis conformis*, one of the most voracious aphis eating ladybird; *Cryptolæmus montrouzieri*, one of the best mealy bug predacious insect, and

some *Chrysopa ramburi*, a beautiful green-laced winged insect, widely distributed in Australia and useful against many kinds of insects; a closely allied species of this lace-winged fly occurs in Fiji, and feeds *inter alia* on mealy bugs, so there will be no necessity for attempting to bring in more of the Australian form.

To the courtesy of Mr. W. B. Gurney, Government Entomologist, New South Wales, this Department is also indebted for a colony of the Ladybird *Coccinella tranversalis*, but as the species is widely distributed in Fiji, no assistance may be expected from the introduced specimens. In addition to Australia and Fiji, the species occurs in many parts of the Malay Archipelago, New Guinea, Lord Howe and Norfolk Islands. It is an aphis eating species and its usefulness is unfortunately restricted by parasites. To guard against the introduction together with the beneficial insect of its own parasites, the adult form or imago was whenever possible introduced. When, however, eggs, larvæ or pupæ were introduced, they were on arrival placed in breeding cages and kept under observation and any secondary parasites emerging were killed as fast as detected.

The Department anticipates good results from the *Cryptolaemus montrouzieri* which were liberated among the mealy bug infested pineapple plantations outside Suva.

VETERINARY INSPECTION OF STOCK IN THE SIGATOKA RIVER VALLEY.

The following report was received from Mr. Charles Turbet, Government Veterinary Officer:—

I left Suva on the 7th January with the intention of carrying out an inspection of stock in Nadroga and as much of Colo West as I was able to in the time which I had allotted for the inspection. Dr. McGusty, however, advised me to do Colo West first, as the weather was fine and this latter province is difficult to travel in during wet weather. I acted on his advice. I was not able to secure the services of a native or Indian policeman, and was obliged to engage the services of two Fijians as assistants.

2. The country covered in the inspection consisted of the valley of the Sigatoka river and adjacent hills as far as Keiasi; from there all the country is a fan-shapped area stretching from Nausori on the west, Bukuya to the north, Namoli to the north-east and Naboutolu to the south-east, with Natuatuacoko as a centre. That part of Nadroga province on the right bank of the Sigatoka river from Waicoba to Lawaqa was included in the inspection for topographical reasons, while the part of Colo West stretching along the coast to the eastward was not seen for the same reasons.

3. During the inspection, 3,300 head of cattle, 605 horses, and about 90 mules were seen. Goats were not found in any great numbers, while sheep have practically disappeared from the district, due, it is said by the owner, to thieving.

4. *Disease.—Tuberculosis.*—There is more tuberculosis in the Sigatoka river district than exists in Nadi and Lautoka. Thirty-four head of cattle, representing one per cent. of the cattle in the district, were found to be affected with clinical tuberculosis; 24 head of these I destroyed personally, the destruction of the remainder being ordered and provision made for carrying this out. Certain areas, notably those upper reaches of the river beyond Natuatuacoko, were found to be free from tuberculosis, while the greatest centre of infection was found to be in Qalimare, near the town of Koronisaqana..

Strongylosis in horses and mules.—A post mortem examination was made on a mule just dead, which revealed severe strongulosis infection, death being due to internal hæmorrhage caused through the rupture of the wall of the anterior mesenteric artery at the seat of a parasitic aneurism.

So-called cancer of the eye and backs of cattle.—One case was destroyed, and the destruction of another ordered. The disease was too far advanced for successful treatment.

Worm infestation in young cattle.—On the few areas where the land was over stock and food scarce, signes of severe worm infestation were seen. No other signs of disease were noticed.

5. *The Stock Improvement Ordinance.*—Only three stallions were found to be licensed in the district. Licences were issued to six other stallions, while seven others were approved off and their licences will be issued on payment of the fees. Should the fee not be paid within one month from the date of inspection, I have given orders that they are to be castrated.

Forty-four stallions were ordered to be castrated, and I personally castrated eight others. This makes a total of 68 stallions accounted for, and roughly shows that there was previously one stallion to every five mares in the district.

No bulls were found to be licensed. After inspection, I issued licences for 41 bulls, while two others will receive licences on payment of the fee. Thirty-five bulls were ordered to be castrated.

This Ordinance is a difficult one to satisfactorily operate, but it is nevertheless a very necessary Ordinance, not only to improve the quality of the stock in Fiji, but also to provide some means of keeping the number of entire animals within reasonable limits. At present owing to apathy or laziness on the part of stock owners, castration of surplus entires is neglected, with the result that there is a menace to the welfare of the stock industry, some personal danger from roaming stallions, and considerable economic loss caused through lack of control of the stock and destruction of fences by bulls. Evidently the Stock Improvement Ordinance was brought into force, not only with the object of effecting improvement in the quality of stock, but also to correct those faults mentioned above.

As far as stallions are concerned, the working of the Ordinance presents no special difficulty. Stallions are brought up for inspection. The best of those presented are passed for licensing and the licence is either issued at once or, if the owner does not have the money, he is told to pay the money to the District Commissioner within one month, and a licence is issued in due course by post. The castration of those not licensed is ordered. The owner can request the inspector to castrate if he so wishes; otherwise the owner is given one month in which to have the operation performed. The Inspector of Stock generally has not time to remain in the district long enough to enforce the carrying out of his orders. European officers and non-commissioned officers of constabulary, however, have the power to demand the production of a licence for a stallion. Failure to produce the licence on demand renders the owner liable to a penalty. This provision should effectively control the unlicensed stallion nuisance, as the owner of the latter animal has no licence to produce on demand, and so is liable to the penalty.

With bulls it is a different matter. I do not enforce the Ordinance with regard to bulls under one year (the age is now fixed at one year). Often the bull licensed is very little better than the one ordered to be castrated. Nevertheless, the absolute mongrel can always be dealt with by the Ordinance, and a means is provided for disposing of the great surplus of bulls.

When the Ordinance fails as regards bulls is that after the inspector licenses some bulls and orders the castration of the remainder within a given time, he leaves the district. There is then no means of forcing those ordered to castrate their bulls to do so. This difficulty would be overcome if the local European police officer were given the same power in respect of bulls as he has with stallions (this has now been done), while at the same time it would provide that local authority which people are constantly suggesting during my inspection tours.

This is a matter which has been much discussed in former reports by Veterinary Officers, and is contained in M.P. No. 4244/21.

6. *Fodder plants and grasses.—Guinea grass* (*P. maximum*).—Nowhere have I seen a more luxuriant growth of Guinea grass than is found in the Sigatoka Valley. At several different places along the river not grazing stock the grass was up to 12 feet high, and dense in growth. Where stock were grazing it was not so high, giving the appearance of being more scattered in clumps. The grass was seeding abundantly, and covering the flats on the banks of the rivers, extending in some places several hundreds of feet up the slopes of the foothills. Looking across the valleys from the opposite hills green patches could in many places be seen extending upward.

Para grass (*Panicum barbinode*).—This grass is only seen covering bila land which is periodically flooded.

Syntherisma consanguinia (*pruriens*).—This was seen growing near Kavanagasau. Hitchcock classes it as a weed.

Syntherisma sanguinalis.—This was also seen, and is classed as a weed by Hitchcock. Both the latter grasses were growing well, and gave the impression of being useful fodder plants. ...

Setaria glauca (Yellow Fox Tail).—This grass is scattered sparsely all along the river.

Panicum distachyum.—This is also scattered sparsely, and is seen on the hills in some places.

Practically all the other grasses common to Fiji were seen, but there is no need to go beyond Guinea, para and possibly panicum distachyum as the most suitable grasses for the district.

7. *Noxious weeds and pests*.—Lantana and guava are spreading up the river and large patches of the latter plant were seen as far up as Korolevu.

Nut grass (*Cyperus rotundus*.—This grass-like member of the sedge family is spreading at an alarming rate. Maiden places it first among the twenty worst weeds of New South Wales, and discusses means of eradication in his book.

8. *Stock*.—The cattle of Colo West are fair in quality where they are under normal conditions. In some areas there is evidence of overstocking, such as in the vicinity of Vunasala, and on a property owned by Mr. Ruthven. Wherever overstocking exists, the type of animal degenerates, the calves are puny, and the adult cattle are ill-developed. Some very fine cattle are to be seen up the river, however, where such curses as guava and lantana have not spread, and the land is still covered by pasture. This is the usual state of affairs up the river. It is evidently a long time since any pure-blooded stock were introduced into the district, and it is difficult to attach the name of a breed to any of the cattle in Colo West. On Messrs. Bryce and Howard's Rasikula Estate dense masses of guava exist on the areas within two miles of the homestead, but has not yet spread to the more distant parts of the run. Some thousand head of cattle roam at large on the estate, and are absolutely out of control. The practice employed is to shoot off a couple of head weekly for supply of meat to the people of the district. A young

two year old bull so destroyed whilst I was there was certainly of good quality and free from signs of disease, and from what I could judge from a distant view of the cattle, this is true of the majority of the beasts. Cows with large calves were rather poor, as is to be expected. The fodder on the hills which constitute most of the run is of a coarse variety, and the native reeds are being eaten out. The small local clover-like plant was noticed widespread.

This is the only attempt at breeding of cattle on a large scale on the Sigatoka river, and it can hardly be described as a success. A considerable sum would be required to put this place on a sound footing. Strong stockyards are required, and wing fences of sufficient strength; while a large force of labour and some improved method would be required to deal with the guava pest. The owners are aware of this. Mr. J. P. Bayly grazes cattle on the river flats for the Suva market. These cattle are brought from Nadi province as stores.

A large number of horses are bred, mostly by Fijians, in a haphazard way around the foothills and reaches of the river from Koronisagana upward. Evidently the country is suitable for their growth and development, as the horses seen were as good as, if not better than, any I have seen in Fiji, in spite of the fact that very little new blood is brought into the district. Very few aged horses were seen, but many aged mares were brought up for inspection. The latter were often of a very fine type, and as a whole, superior to the horses. I take it that the aged horses are disposed of in trade to the Indians and others on the coast from Ba to Lawaqa. These fine mares never miss a season in foaling, and at times they were seen with a following of three generations. Unfortunately, there has been little restriction on the type of sire. Among the colts two very fine animals were seen, one a chestnut colt of 16 hands at 2½ years, and of excellent conformation, the other a bay colt of 3 years and 15·3 hands, also of good conformation and first-class action. One might easily mistake them for imported thoroughbred horses. Possibly the outcrops of limestone which occur in that district may account for the excellent development of the horses. A restriction in the number and licensing of the better types of stallion, as I have attempted to do, should cause a general improvement in the horses.

9. It surprises me that the Sigatoka tiver valley has gone so long unsettled and undeveloped. I have not seen better natural land in Fiji, and it has many advantages over places which have been made a success of without those advantages. There is no clearing of timber to be done, in fact the scarcity of timber may be a slight disadvantage in some respects. Koster's curse is not known there, and guava and lantana are localised in their distribution. A fine river exists, navigable for punts for 40 miles. The whole valley is well grassed, and the rainfall is not so great as to cause difficulty in farming. The land is too rich from the crop farming point of view to be used purely for pastural pursuits. The district is admirably suited for mixed farming. Each farm would have a river frontage and a proportion of rich river flat. The latter land should be utilised chiefly for crops, while the bila land close to the river would keep milking dairy cows in excellent condition. In addition, portions of the first land could be utilised for cattle, and by assisting the spread of guinea grass on to the hills and the establishment there of other grasses suitable for the climate, such as Rhodes grass, immense numbers of cattle and perhaps sheep could be run on that land. The crops growing at present, and those out of season, are:—Maize, bananas, cassava, potatoes, rice, cotton, tobacco, pineapples, and all the native vege-

tables, while on the few company estates towards the mouth of the river, sugar-cane grows luxuriantly.

In conclusion, I would state that the agricultural and pastoral possibilities of the Sigatoka river district in my opinion are great, and I would draw the attention of this Department to them.

P.S.—To paragraph 7, dealing with noxious weeds and pests, I omitted reference to a plant of the *genus solanum*. This plant is widespread in Fiji, and is particularly prevalent in Colo West. In some localities it is growing to a height of 14 feet and so thick and luxuriently that progress through it is impossible. It may prove a serious menace in the future if not dealt with.

THE STOCK IMPROVEMENT ORDINANCE.

In order to improve the machinery for carrying out the provisions of the Stock Improvement Ordinance and inforcing the castration of bulls and stallions not passed by the Government Veterinary Officer for licencing, a conference was held between the Acting Superintendent of Agriculture, Inspector-General of Constabulary and the Government Veterinary Officer. The following arrangements were made:—

(*a*) The Government Veterinary Officer will notify the Inspector-General of Constabulary of his intention to inspect stock in a certain district;

(*b*) The Inspector-General of Constabulary will notify the local police of the intended visit and order that all assistance possible will be given to the Government Veterinary Officer;

(*c*) After inspection of the stock the Government Veterinary Officer will hand to the local police officer and also to the Inspector-General of Constabulary lists of animals dealt with, as follows:—

(1) stallions licenced;
(2) stallions passed for licencing;
(3) bulls licenced;
(4) bulls passed for licencing;
(5) stallions ordered to be castrated;
(6) bulls ordered to be castrated.

(d) After a reasonable period, the Inspector-General of Constabulary will ask the local police officer to report on what action has been taken concerning the lists which were handed to him;

(*e*) the Inspector General-of Constabulary will then notify the Government Veterinary Officer as to what action has been taken.

District Commissioners, as in the past, will be requested to assist the Government Veterinary Officer in drawing up an itinerary for the inspection of their district in order to facilitate the inspection as much as possible.

The police have power to enforce the Veterinary Officer's orders by demanding the production of a licence for a bull or stallion. The result of failure to produce licence is prosecution.

CATTLE TICK PREVENTION.

At the present time our regulations permit the importation into Fiji of cattle from the United Kingdom, New Zealand, and such parts of Victoria, South Australia and New South Wales as are certified to be free from cattle tick. Although the Australian cattle tick *Margaropus australis* has penetrated the north-eastern corner of New South Wales, they are there not known yet to be infected with the tick fever germ which produces *piroplasmosis* in infected cattle in Queensland. The restrictions regarding the introduc-

tion of cattle from New South Wales are so framed that there is practically no danger of introduction of the cattle tick *Margaropus australis* from New South Wales, although it is possible, but highly improbable, that ticks of other species may be carried on stock from that State.

In New Zealand another species of cattle tick occurs, the *Hæmaphysalis bispanosa*, and is very prevalent in the North Auckland and Coromandel Peninsula and a few other scattered places. These ticks, although causing an acute skin irritation known as " tick worry," are not known carriers of tick fever (called " red water " in South Africa). Under the present system of inspection at both port of shipping and port of entry, declaration of health by a veterinarian, dipping at the port of shipping, it is quite improbable that this tick either could be introduced, but as its hosts are not confined to cattle and as the distance from New Zealand to Fiji is much shorter than from Sydney to Fiji, and also as this particular tick is known to be prevalent in the neighbourhood of the port of Auckland, the danger of the tick being transported to Fiji is one that cannot be ignored. It is significant however that cattle are allowed into New South Wales from New Zealand without quarantine or dipping as long as they are accompanied by certificates of health and tuberculosis test certificate.

This Department has for some time given attention to the matter of tightening up the regulations governing the importation of stock and of safeguarding the state of freedom from diseases and pests they at present enjoy in Fiji. Recommendations have accordingly been submitted and the matter has been thoroughly discussed with breeders and stock owners, with the result that the merits of both dipping and also of drenching the animals by means of power spraying machines capable of dealing expeditiously with herds of cattle have received consideration, Government having decided that additional protection must be provided against the possible introduction of cattle ticks.

LANTANA PARASITES.

Early in 1923 efforts were made by the Department of Agriculture to supplement the work of the Lantana fly *Agromyz lantanæ* against that troublesome shrub, and thanks to the courtesy of the Hawaiian Sugar Planters' Association (per Mr. O. Swezey) a number of the Lantana flower-feeding butterflies *Thecla agra* and *T. echion* were obtained from Honolulu and liberated; *T. agra* on the outskirts of Suva and *T. echion* at Mua in Taveuni.

Shortly after his return from his mission of investigation regarding the habitat of the Levuana moth, the Acting Entomologist was able to observe and to report that *T. agra* is well established and busy at work on Lantana flowers and that, together with the Agromoyz fly parasite on the berries, it is spreading all round Suva.

From Taveuni, Mr. Bull, of Mua, who originally received the pupæ of *T. echion*, reports that a few specimens were observed recently.

This Department will therefore soon be able to supply to applicants these useful parasites.

Where the Agromyz fly is established, there is hardly a single berry that reaches maturity as one by one they drop off the pedicel after being punctured by the minute Agromyz wasp. Although the bushes' growth is not in any way impaired by the attention paid to their flowers or to the berries by the parasites, it is expected once they are cut down and burnt, there will be few if any seed present to start a fresh growth.

LEVUANA.—ALLEGED OUTBREAKS OF THE MOTH.

Investigations made by the Department of Agriculture regarding the report credited to Captain Bucknell of the presence of the Levuana Moth on Bua Coast, Vanualevu, show that it is another instance of the presence of scale being mistaken for the more serious pest.

A similar conclusion was arrived at regarding the recently reported discovery of Levuana on Kadavu, which also proved to be a case of mistaken identity.

Much anxiety and delay would be saved if specimens of affected leaves were, in doubtful cases, submitted at the same time as the information regarding a new outbreak is circulated.

BANANA BORER CONTROL.

The introduction from Java, made eleven years ago by the then Entomologist, Mr. F. P. Jepson, of the predaceous beetle *Plaesius javanus*, and which has been referred to in previous issues of this Circular, has now been proved to have been highly successful. A search made in 1921 resulted in the recovery of only one beetle. When visiting the banana packing stations along the Rewa river soon after my arrival I arranged with the Inspector of Produce, Mr. E. Gordon, and with Mr. J. Cocks, of the inspectorial staff, to have a fresh searching examination made around an abandoned plantation on the Waidina, where one of the original batches of the beetles had been liberated. The result of the search has been highly gratifying, and within a few weeks over 100 *P. javanus* beetles were forwarded to headquarters. Since this, another 3,500 specimens were collected and distributed.

These predaceous beetles were, when introduced, sent out in colonies 500 strong to the Nasinu Experimental Station on the Rewa Road, Toga Island, Viria, Nukumotu on the Rewa, Nabalawa on the Waidina, Lami and Taunovo at Navua. As a natural control for the banana beetle borer, which, introduced not many years ago, caused serious damage to banana plantations, it will be of material value. Although its activities in borer infected plantations here not yet been systematically invested, it is reasonable to infer that now that it is widely established they will be most hopeful for the control of the pest.

Mr. Jepson's observations showed that in subdued light, in captivity, five larvæ of *Plæsius javanus* consumed an average of 11 larvæ of banana borer each per day. In the dark they consumed an average of 33·8 per head a day. Each larva or grub consumed daily grubs of banana borer equivalent to 17 times its own size. The adult of this predaceous beetle also feeds on the larva of the borer beetle. Under observation it was shown to consume 8 grubs a day. We may, therefore, expect good assistance from that quarter.

This predaceous beetle is also said to attack the larvæ of the sugar-cane weevil borer (*Sphenophorus obscurus*), a closely allied species to the banana beetle borer (*Sphenophorus sordidus*).

The *Plæsius javanus* beetle carries well in captivity and takes readily to small pieces of raw meat; as however they like their food fresh, these small lumps should be removed when they have had a feed, and this need not be repeated every day. The Department of Agriculture will be prepared to make arrangements for the collecting and the distributing of colonies of these beetles at a price that will cover cost, or 10s. a 100, and those desirous of securing some for their plantations can make their requirements known.

The beetles collected (4,638) were distributed in colonies numbering from 50 to 1,200 to plantations along the following rivers:—Wainibuka, Wainimala, Waidina, Waidrau Creek, Rewa, Wainibokasi, and at Nasinu School, Tamavua, Lami, Navua, Suva, Tailevu, Vitilevu Bay, Savusavu Bay and Kadavu.

DAIRY STOCK IMPORTATIONS.

During the last twelve months the importations into Fiji of pure-bred dairy stock has been brisker than for a long time past. This is accounted for by the practical demonstrations conducted under well organised modern factory methods at the Sailors and Soldiers Dairy Scheme at Tailevu; also to the additional impetus given to dairying both by the newly-opened, co-operative dairy factory on the Rewa, and by the proprietary dairy of the Fiji Pastoral Company on the Navua flats.

A list is given below of the importations since the beginning of 1923:—

1923—*May.*—Two bulls and 53 Jersey heifers from New Zealand for the Fiji Pastoral Company.

June.—One bull and 20 Friesian heifers from New Zealand for Mr. McKenzie, Rewa; two Friesian cows from New Zealand for Mr. A. Cox, Brighton Park Dairy.

October.—Five Friesian bulls, 2 Jersey bulls, 6 Jersey heifers for the Tailevu Dairy Scheme, and one cow from New Zealand.

December.—One milking Shorthorn bull from New Zealand for Mr. Beddows, Taveuni.

1924—*March.*—One bull and 4 milking Shorthorn heifers from Australia for Mr. G. Kiss, Rewa. These cattle are related to the famous Melba strain of Darbalara stud.

April.—Three Friesian bulls for Mr. P. Costello; one Jersey cow for Mr. Ellis; four bulls and 53 Friesian heifers for the Fiji Pastoral Company, Navua. All these came from New Zealand.

June.—One bull and three Jersey heifers for Mr. Meecham, Tailevu.

FIJIAN HORSES FOR NEW ZEALAND AND AUSTRALIA.

To remove the embargo against the importation of Fiji-bred and owned horses into New Zealand, correspondence was entered into between the Governments of Fiji and of New Zealand requesting the modification of the stock importation regulations so as to allow horses in from Fiji. At the same time a list of diseases present on horses in Fiji was submitted to the Government of New Zealand. The prohibition has now been lifted and the request has been granted under conditions notified to the Government of Fiji in the following communication:—

Office of Minister of Agriculture,
Wellington, 31st March, 1924.

The Acting Colonial Secretary,
Colonial Secretary's Office, Suva, Fiji.

Dear Sir,

Referring to your letter of the 24th January regarding the prohibition of the introduction into New Zealand of horses from Fiji, I beg to advise you that after careful consideration it has been decided to amend the quarantine regulations to permit of the introduction into the Dominion of horses from Fiji, on the following conditions, and the necessary amendment to the regulations is being drafted:—

1. A declaration from the owner certifying:—
   (*a*) That the animal has been free from disease during the six months next preceding the date of shipment;

(*b*) That it has not been in contact with any animal suffering from disease during the six months next preceding date of shipment;
(*c*) If imported into Fiji from New South Wales, Victoria, South Australia, or Tasmania, that the animal has been continuously domiciled in either state and Fiji for not less than six months next preceding date of shipment;
(*d*) If imported into Fiji from any other country from which the importation of horses into New Zealand is permitted, namely, the United Kingdom, Canada, or the United States of America, that the animal has been continuously domiciled in either country and Fiji for not less than 12 months next preceding date of shipment.

2. A certificate by the Government Veterinary Surgeon:—
(*a*) That the animal is free from disease; and
(*b*) That he has applied the Mallein test with negative results.

3. The animal to be subject to a period of 28 days quarantine on arrival in New Zealand.

I may say that an earlier decision has not been reached because it was necessary, in view of the movement of stock between this Dominion and Australia, to first ascertain that the lifting of the embargo against horses from Fiji would not prejudicially affect New Zealand in so far as the Commonwealth quarantine regulations are concerned.

I may add that I am advising the Director-General of Health, Melbourne, of the action which has been decided upon, and it is probable that the Commonwealth Authorities will now also amend their regulations to permit of horses being admitted into Australia from Fiji.

Yours faithfully,

W. NOSWORTHY,
Minister of Agriculture.

Similar negotiations which were in progress with the Commonwealth Government have now resulted in a Gazette proclamation, dated 10th July, repealing the prohibition of the importation of horses from Fiji, subject to quarantine.

FIJIAN-BRED ZEBUS FOR THE SOLOMONS.

With much foresight, Mr. Leslie Brown, the of firm of Brown & Joske, imported from India some years ago a few pure-bred Zebu cattle, which, as anticipated, quickly impressed their type in several herds in Fiji. These Zebus of the heavier class of Indian cattle, the Hissar, cross well with any other cattle in the tropics, the progeny thriving under conditions met with there. They grow to a large size and make grand bullocks, much esteemed for traction work, being quick of pace and tireless. Even cattle with a distant strain of Zebu blood show remarkable resistance to most cattle diseases, including *piroplasmosis*, or tick fever. Bring good graziers, they thrive where other cattle would starve, and they do not mind heat or rain. When handled properly they are quite tractable, although at times they certainly are lively when strangers are about.

Ten head of these pure-bred cattle were recently sold by Messrs. Joske and Scott, of Suva, to Lever Bros. Ltd. for their Solomon Islands plantations, and left a few weeks ago *via* Sydney for their destination.

RICE-BRAN.

One of the grudges of the farmers in Australia is that the bulk of the wheat is exported as it comes from the field, thereby robbing the country of the mill offal—bran and shorts or pollard—required by the stock owner. So great is the demand for these by-products that although a large quantity of flour is also exported , all the bran easily sells in the country, and the demand is so great that the ruling price, although generally high, is readily given.

In Fiji, where rice is also a staple food and the bulk of the paddy is hulled and cleaned locally, there is a notable quantity of bran made available, that,

from samples submitted by the Government Rice Mill and analysed by Mr. C. H. Wright of this Department as shown below, compares closely with wheat-bran in its chemical composition.

	Rice-bran. *Suva.*	*Wheat-bran.*
Water	9·0	10·1
Protein	12·2	16·0
Oil	5·8	4·4
Carbohydrate (starch)	57·7	53·7
Fibre	8·0	9·5
Ash	7·3	6·3
	100·0	100·0

With a little less nitrogenous matter (protein) than in wheat-bran, it is as rich as a food-stuff, containing as it does more fat and more carbohydrate. The palatability to stock of the one is as good as that of the other, and according to digestibility tables, the percentage of nutritious matter assimilated also shows a close resemblance with wheat bran.

The analysis also shows a close resemblance as regards "food units," calculated on the figures given. The food units of any feeding-stuff are found by multiplying the sum of the percentages of protein and oil by 2½ and adding to the product the percentages of carbohydrates. In the case of the above analyses the value are as follows:—Rice-bran, 103; wheat-bran, 105. From the foregoing it follows that rice-bran is only two points below wheat-bran as regards "food units" values, but where the advantage is strikingly in its favour is in relation to the cost on the local market, where one would expect that the prices of these two feeding-stuffs would be proportioned to these numbers, or in other words, that the price of rice-bran per cwt. would be 103/105 of the price of wheat-bran per cwt.

From quotes before the Department of Agriculture it has been ascertained that whereas wheat-bran is selling at 16s. 6d. per cwt. or 3s. per bushel of 20 lb, rice-bran is offered by the Government Rice Mill at 5s. by the bag of 112 lb, or 3s. per bag in ton lots, or in other words 1/3·5 to 1/5·5 of the price of wheat-bran per cwt. This comparison with a standard stock-feed of undisputed value shows that our rice mill can offer in the bran which is a by-product of rice polishing, the cheapest concentrated food on the market.

It must also be understood that rice-bran varies in quality, some embodying the whole of the husk of the paddy which naturally greatly lowers its feeding value. The bran turned out by the Government Rice Mill conforms with analysis given above.

In countries where rice is largely grown the bran or meal resulting from the hulling and polishing process is largely used as food-stuff for fattening pigs, milch cows and also for transport mules. It has been observed in Italy that those dairy cows receiving a ration of 5 lb of rice-bran a day often developed a cough which disappeared when the quantity was limited to 4 lb. At the High School of Agriculture, Milan, it has been found that 770 grammes (1½ lb) of best rice-bran or 860 grammes (1¾ lb) of second quality can with advantage replace 1 kilo (2·2 lb) of wheat-bran. In Madagascar, where rice is extensively grown and where the offal of milling is used for stock feed, it is this bran or rice meal which allows the Malagasis to raise the 3,000,000 francs worth of lard exported from that French Colony.

MELBA XV—THE WONDER COW.

J. T. Cole, of Darbalara Stud, Gundagai, New South Wales, the property of the Scottish Australian Investment Company and the breeder of the famous Melba family of Australian dairy Shorthorns, including Melba XV, the world champion cow, contends that the highest producing cows in Milking Shorthorns are those that have a robust frame, plenty of size, fine bone, good quality and a great aptitude to fatten when dry. For production, the leading heifers in a group will be found in those that mature early, and when in calf show a strong tendency to lay on flesh, not in undersized, light fleshed, slow matured animals.

During the last day of her 365 days' test under departmental supervision, Melba XV yielded in three milkings 46½ lb of milk, with an average test of 5·95 per cent. equal to 2·76 lb butter fat for the twenty-four hours. For the 12 months she yielded a grand total of 32,522¼ lb of milk and 1,614 lb of butter fat.

That wonder cow is the fifth of a direct line showing a record over 273 days' testing periods as follows:—

	Milk. lb	*Butter.* lb
Madame of Bolaro (16 years) ..	7,763	308
Melba (no record)	.. ....	..
Melba IV (1 year)	11,763	498
Melba VII (6 years)	14,371	712
Melba XV (6 years)	22,597	988

At the end of the 365 days of the same test she gave 1316 lb, butter fat.

As seen above the cow has in her seventh year and at the expiration of 365 days' test, not only surpassed her previous yield but has added to the wonderful performance of beating the world's record on an authentically conducted twelve months' test. Not only does she show inherited production, but she also passes it onto her immediate offspring which are all high class butter producers.

This particular strain is represented in Fiji by a small herd of four cows and a bull recently imported from New South Wales by Mr. G. Kiss for a stud established on the para grass flats of the Wainambuka on the upper Rewa. With a carefully laid down line breeding, ensuring prepotency and the advantages Fiji pastures offer when fed in conjunction with well-balanced grain ration, this herd should not only maintain its established reputation but should infuse valuable qualities in the Colonial dairy herds.

HERD BOOK FOR GOATS.

No farm stock has so far received less systematic attention than goats in Australia, New Zealand and the Pacific. In other parts of the world—Switzerland, Malta, North and South Africa, America and of late years in England—recognition of their worth as milkers and meat producers has led to the formation of goat societies.

In Australia they still figure on the Statute Books as vermin that may be shot at sight when found trespassing on farms.

The Australian Angora and Milch Goat Breeders' Association has been formed to maintain the purity of breeds and popularise these useful animals who thrive where sheep cannot be kept. All goat breeders are invited to

join the Association which has its headquarters in New South Wales. Further information may be obtained from the Hon. Secretary of the Association, Burgooney, N.S.W.

The mohair is to South Africa what wool is to Australia and to New Zealand. The milk is invaluable for children and for invalids, being easy to keep down when other milk is rejected by weak constitutions. The flesh of kids or of wether goats is in every respect as good as mutton of the same class.

In Fiji the caprine population is fairly considerable and estimated at 13,500. It consists chiefly of inbred stock, mostly of Indian breeds, with here and there an infusion of Angora strain. That they do remarkably well is a matter beyond doubt, the large Indian population offers a ready market for goats and a billy always finds a purchaser willing to pay a price, rising with size and rank smell, for young bucks according to Indian tenet are not as a rule wethered.

FIJI PINEAPPLES CANNED IN CANADA.

On his return to Fiji in October last, Mr. E. Jerome Dyer, who had for some time been active in urging canning firms in Canada to make a practical test of Fiji pineapples for canning, received from the Dominion Canners Limited the following encouraging letter:—

Dominion Canners Limited,
Hamilton, Canada, 27th September, 1923.

Dear Mr. Dyer,

We ourselves, at present, as you know, are canning pineapples in our Canadian factories from the pines which we import from the West Indies. The price, however, which we have to pay for these makes it difficult for us to compete successfully with the Hawaiian pines. There is a large and steady market for canned pineapple in Canada and if the Fijian pineapples are equal to the Hawaiian and if they can be grown in quantities and supplied to the factory at the price you mention, and if labour is procurable at the prices you have advised, there is no reason why this business should not reach very large proportions.

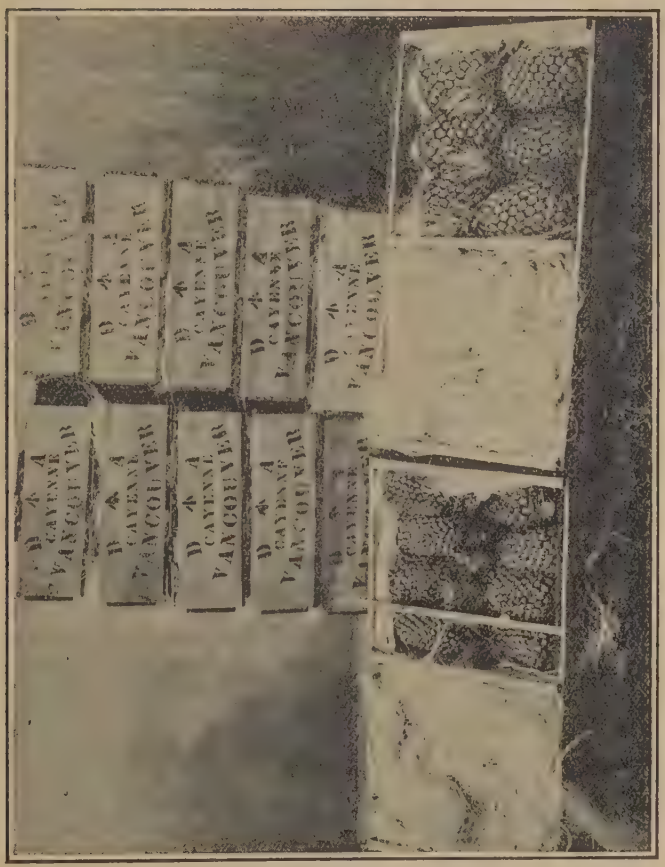
Pineapples, of course, cannot be grown in Canada as our climate is not suited for that purpose, and the West Indies pines cannot be produced to reach our market at as economical a price and therefore we are of the opinion that if the Fijian pines can be marketed as mentioned to us by you, we are confident that our Directors will go ahead and make a beginning in co-operation with the English interests and develop the business as conditions warrant.

We are of opinion that the first step necessary is to satisfy ourselves as to the suitabulty of the Fijian pineapples for canning purposes and therefore we shall be glad if you will cable us immediately on your arrival in Fiji if any of these pineapples are ready for canning. If so, we may ask you to ship 50 cases promptly to our Vancouver factory where we can have them canned for experimental purposes, or we may decide to send our representative by first steamer to Fiji for the purpose of inspecting the fruit and ascertaining if canning in the Fiji Islands is a commercial possibility. If these reports are satisfactory it will be our intention to continue negotiations towards the formation of a company in association with your friends in England and along the lines which we have discussed.

Yours very truly,

W. R. DRYNAN,
Secretary, Treasurer and Director.

The Government decided to comply with the request and the Agricultural Department was instructed to make necessary arrangements. With the co-operation of the Union Steam Ship Company space was secured on the November boat in a small cool chamber on board the s.s. " Niagara," which by arrangement was to be maintained at a temperature approximating 50 to 55 degrees. The consignment consisted of 50 cases Azores export for London size, 40 in. by 20¾ in. by 7½ in. outside measurement. The varieties were those grown in Fiji, viz., the smooth-leaved Cayenne and the Ripley Queen. The smooth-leaved Cayenne ranged in size from 3 lb to 6½ lb and averaged 4¼ lb. They were carefully packed in single layers with the butt



FIJI PINEAPPLES SHIPPED TO CANADA FOR CANNING.

of the stem The Ripley Queens are the kind at present favoured for the Fijian fresh fruit export market. That variety, although smaller, is hardy, of excellent flavour and sugary. A request was made for a report on the state of the differently branded packages on arrival. From official source the Department was informed that the majority of the pineapples arrived in excellent condition and were as fine a sample as any that have been shipped to Vancouver—"Such fruit should command good market in Western Canada at any time of the year. Samples that have been received from the Hawaiian Islands and Florida recently have been all of an inferior grade."

Reporting to the General Manager, Canadian Government Merchant Marine Limited, the assistant to Pacific Coast Manager referred to the shipment of the Fijian fruit as remarkably fine, and this was the concensus of opinion of importers on the wholesale row.

In February last the Department of Agriculture received from the Dominion Canners, B.C., Ltd. two cases of canned pineapple with the encouraging report that "the pineapples arrived in first-class condition, and were about the finest looking lot of pineapples that we have ever seen. Shortly after arrival we started to can them, but found only a portion of them ripe enough for the purpose. The rest we put in a warm room for about three weeks and found them still too green to can, so that these were evidently picked too immature."

The cans consisted of smooth Cayenne and of Ripleys of the following grades:—"Fancy," "Choice," "Standard," "Tidbits," "Shredded." They were tested and compared with canned pineapples from Hawaii, Queensland and Singapore by members of the Loan Committee, British Empire Exhibition Committee, the Press, and representative business men at McDonald's Hotel, kindly placed at the service of the tasters by Mr. H. G. Pateson. The general conclusion was that of great satisfaction at the success of the Fiji pines which come out triumphantly from the test.

WHEAT GROWING IN FIJI.

The importance of being able to grow locally the wheat required to produce the 12,000,000 lb odd (6,000 tons) of flour, sharps and pollard, worth £80,000, which Fiji requires annually, gives to the question an important significance. There are on Vitilevu as well as on Vanualevu fairly extensive stretches of valley or foot-hill land, which in the drier zone or leeside of these islands should be capable of producing not only the bread stuff of Fiji but that of some of the adjacent islands as well. Rust or other fungoid diseases may prove an obstacle to attaining this achievement, but the experiment is worthy of trial and there does not appear to be any unsuperable difficulties in the attempt.

It is proposed this year to experiment with one sample of wheat submitted for trial by the Hon. Henry Marks, and next year it may be possible to test some specially selected rust resistant wheats from India. The wheat this year is "Florence," which has shown some degree of rust resistance, and it is thought that it ought to suit this climate. It is an early wheat, which is suitable for hay or for grain and in the coastal districts of New South Wales where rust attacks a number of other varieties it is found valuable for green feeding, grazing and soiling.

Preparation of the land.—Plough or dig in the ordinary way six inches deep and then harrow the ground to make it even.

Pickling the seed.—Unless the spores of the Bunt fungus, which are sown with the seed, grow with the plant and infect the grain turning the white, starchy kernel into a black, powdery mass of spores with an unpleasant smell, are destroyed the crop is often considerably reduced.

Pickling by killing these spores which might be adhering to the surface of the seed is essential. A diluted solution of formaline or of copper sulphate (blue stone) may be used. The grain which is placed in coarse sacking is dipped into a wooden tub for 3 to 5 minutes, the bag then hoisted out and allowed to drain. The strength is 1 lb of formaline in 40 gallons of water (1 oz. in 2½ gall.)and the wheat should be sown at once. If blue stone is used the strength is ¾ lb in 4 gallons of water (3 oz. in 1 gall.), after which dip for another period of 3 to 5 minutes in lime-water. When dry it is either sown or placed in also dry pickled bags and kept till ready to sow.

Sowing.—Sowing can be done on small trial plots by dibbling in at distances 4 inches apart or broadcasting if a larger plot is sown. In Fiji where heavy rains may at times do harm to the crop, undulating ground is better than flat country, as it drains better and is not so likely to cause rust in the wheat.

MOLASSES GRASS—(EFWATAKALA).

By A. Despeissis, M.R.A.C.,Acting Superintendent of Agriculture.

A request was made to the Department of Agriculture some months ago to make the fullest inquiries about that grass, and whether it would destroy or partly destroy Johnson grass, one of the most unfortunate introductions into this Colony, where it has been proved ineradicable on sugar-cane land. The hope was also expressed that if it could suppress Johnson grass, it would also very likely smother Koster's curse (*Clidemia hirta*) which is being spread far and wide on the moister side of the islands.

The grass referred to is synonymous with what has been described lately in agricultural papers as " Molasses grass," which, when fresh, has a distinct odour of sweet cured tobacco, the leaves being covered with glandular hairs which secrete a viscid exudation. The botanical name of this grass is *Melinis minutiflora* var. Pilosa. It is a native of Africa, and also of Central America and Madagascar. Stock, it is said, will not at first graze it readily unless paddocked on it, but they eat the hay freely when they have become used to it. Although it does not seed habitually except in the tropics, it is easily propagated from runners growing rapidly and smothering vegetation.

According to the *Rhodesia Agricultural Journal*, 1918, p. 328, it is perhaps the best hay grass yet introduced into Rhodesia. For dry fodder it should be cut before the seed heads show themselves. As a result of trials in Queensland and in New South Wales, it is considered likely to prove a good fodder grass. It is a grass 2 ft. to 2½ ft. high and rooting at the joints,; it covers a large area of ground speedily.

In Brazil two kinds are spoken of, the hairy and the non-hairy or glabrous. The Portuguese names in Brazil, *Capim Mellado* and *Capim Gordura* mean " honey grass " and " fat grass " and there, adds an observer, horses and cattle seek it and fatten on it, but they acquire little vigour.

A de St. Hilaire, the observer referred to above, gives a curious account of the way in which this grass covers the ground continuously for leagues together to the exclusion of everything else in the province of Minas in Brazil, " spreading farther and farther wherever the woods were cut down and burned, and smothering all the smaller and weaker plants till it reigned alone over extensive tracts."

The replies to the inquiries made were:—

From the Government Botanist, Queensland, who states *inter alia*:—The Brazilian stink grass or Molasses grass was introduced into Queensland in 1901, but has never spread to any extent, and I think has now died out completely. Hence we have little local knowledge of the grass and we are also unable to supply seeds or runners.

From the Under Secretary and Director of Agriculture, New South Wales, stating that the Department's experience with molasses grass is that it would not be of much value in suppressing Johnson grass, as it would be expected the latter would choke the former. Molasses grass is not readily eaten by stock in this state, and there are other grasses that are more vigorous growers then it, but once established they would be difficult to eradicate. The time and labour devoted to the planting of Molasses grass and the checking of Johnson grass and Koster's Curse, to enable Molasses grass to become well established would, in the opinion of the Department, be more profitably devoted to the eradication of the Johnson grass and Koster's Curse than to planting the first named grass.

From the Agronomist in Charge, Hawaii Agricultural Experimental Station:—Due to the fact that Johnson grass exists only in certain and limited areas in Hawaii we have no experience with the Molasses grass for suppressing this obnoxious grass. However, from observation we found that the Molasses grass keeps down the Nut grass (our most objectionable weed pest) fairly well if given a good start. It makes a rapid growth and commences to form a mat-like cover with its prostrate stems. The growth of the Nut grass ceases in and around the covered area. The corms of the Nut grass remain dormant and will become active again just as soon as the Molasses grass is removed. The Molasses grass can be kept under control and there is no danger of its jeopardising the growth of other nutritious grasses in the same area. It blooms annually and if it is desired that the seeds are not to be disseminated the field can be pastured just when the grass shows signs of blooming.

Packets of seeds advised to have been sent to this Department from Honolulu have not yet been received. From the foregoing this grass does not appear to be proved a pest. In Australia it has not yet met with conditions favourable to its growth. In Hawaii it has given a better account of itself. It is worth growing under observation, but it is not likely to prove the long looked for weed smotherer and stock fattener it has been represented to be in portions of Brazil.

PASPALUM GALMARRA.

Attention having been directed to that grass by Mr. W. Hamilton, the Manager of the Tailevu Dairy Scheme, the Department made inquiries from the Under Secretary for Agriculture, Queensland, who referred the matter to the Government Botanist, and the following information has been courteously submitted:—

The Russell River Grass ia not grown about Brisbane. It is very common in North Queensland. It was named *Paspalum galmarra* as a new species, but has since been found to be identical with *Paspalum paniculatum*, a grass with a wide distribution over the tropics of the world, particularly South America. As mentioned by the Superintendent of Agriculture at Suva, *Paspalum dilatum* does not thrive under definitely tropical conditions. This can be seen in the low-lying country in North Queensland where it makes a very poor growth; on the table-lands such as Atherton, however, with a cooler climate, it thrives admirably.

The Russell River Grass is not considered a particularly good dairy grass and where it and *P. dilatatum* grow together the latter is considered far superior. Russell River Grass, however, in Tropical Queensland has some value as a horse and cattle fodder, and where other grasses will not grow should have some value as a dairy grass.

Seed is not stocked by seedsmen as the grass has gone out of cultivation, but wild supplies are obtainable. The Manager at the State Farm, Kairi, if written to, should probably arrange for 20 lb to be gathered.

This was duly done and the Department now gratefully acknowledges from the Manager a small parcel of the seed for trial, with the information that—

This grass wants heavy stocking and if not has a tendency to rankness and becomes very coarse. When cut on the green side before the seed has ripened it makes a good hay and chaff. Being a comparatively shallow rooter it is easily eradicated from cultivation. While it is not looked upon too favourably in these parts it has carried many head of stock in severe droughts.

WATER HYACINTH.

The water weed, *Eichornia crassipes* which is infesting the lower reaches of several of the rivers is one more instance of thoughtless and regrettable introductions into Fijian waters.

In Queensland it has long proved a troublesome weed on the waterways of sluggish rivers, and a great deal of money has been spent in trying to keep it within bounds.

In East Bengal, the granary of the province, water hyacinth has spread with amazing rapidity within recent years, and has invaded large extents of paddy land and made them unproductive.

The plant, which possesses a beautiful blue flower, propagates in the water by stolons or runners, and a single plant can in a few months cover a big patch. The trouble seems to be getting more pronounced, and unless tackled energetically will become costly to control. Some of the blind creeks along the Rewa are already covered and it is a common sight to notice floating bundles of para grass and of water hyacinth drifting up and down the river according to the tide. A fruitless effort was made some years ago and resulted in the weed being spread more extensively in the endeavour to destroy it when it was torn from the banks of the river and towed outside and dumped outside the mouth into the sea, but the rising tide took back much of it again.

Cattle eat it readily on shore, so that whenever practicable they would dispose of it if dragged out of the water and left high and dry on the banks. where it would be eaten or would perish and leave a compost rich in potash.

Various means have been tried to destroy it in the water, mainly by spraying with poisonous solutions such as sodium arsenate, copper sulphate, or bluestone. These give promising indications of being efficacious at first, but often prove inadequate in killing the plant throughout. A poisonous solution moves upwards and only under special conditions downwards, so that there is at first an apparent wilting, but the submerged roots remain active and throw new growth.

"TROPICAL AGRICULTURE."

Tropical Agriculture, the official journal of the Imperial College of Tropical Agriculture, Trindad, is issued monthly under the editorship of Professor W. R. Dunlop. The source from which this publication springs, is in itself a guarantee of the value it represents to all engaged in plantation work in the tropics and its circulation should therefore become widespread and considerable. In order to add to its popularity the subscription has been set down at the low price of 6d. a copy or 5s. yearly, post free.

FIJI BANANAS FOR EXPORT.

For export the trade requires bunches of nine hands and over, any bunch under nine hands being valued at a lower price. An eight-hand bunch, for instance, is worth three-quarters the value; a seven-hand one half, and a six-hand bunch only a quarter the price. In Fiji any bunch under nine hands is broken up into fingers or into hands, as the market requires, and the fruit is shipped in cases. These are of two sizes and are made of light boards, like crates, viz., the 3 ft. double case, with a central partition, for the New Zealand market, and the bushel export tropical fruit case for the Commonwealth of Australia. A 3 ft. case weighing 10 lb when properly packed holds in fingers 70 to 75 lb weight of fruit, and these are picked green and three-quarters full; a bushel case holds about 65 lb net. A hand carries from 20 to 25 bananas on the top or nearly double the number carried on the bottom hand.

The illustration gives a good idea of the respective sizes and appearance of the two export kinds grown in Fiji. The Cavendish, China or Dwarf kind is the favourite, being hardy and standing heavy blows better than the taller Gros Michel. The two bunches shown side by side in the illustration are fair samples of export bunches, and their size, weight, number of hands, and number of fingers to each hand, with the size of the fruit are given for the sake of comparison in the table below:—

No. of hands.	Height of bunch.	Circum. of bunch.	Hands.	Fingers.	Length of fingers.	Circum. of fingers.	Weight of fruit.	Weight of stalk.	Total weight.
CAVENDISH—THREE-QUARTERS FULL (14/4/24.)									
					in.	in.			
11	26″	40″	1	24	5	4¾	46lb	5lb	51lb
			2	24	5	4¾			
			3	22	5	4¾			
			4	20	5	4¾			
			5	20	5	4¾			
			6	19	5	4¾			
			7	18	4½	4¾			
			8	18	4½	4½			
			9	16	4½	4½			
			10	16	4½	4½			
			11	14	4	4½			
			..	211	..	..			
GROS MICHEL—THREE-QUARTERS FULL (14/4/24.)									
					in.	in.			
10	30″	40″	1	20	7	5¼	51lb	6 lb	57 lb
			2	20	7	5¼			
			3	18	6	5¼			
			4	18	6	5¼			
			5	18	6	5			
			6	16	6	5			
			7	16	6	5			
			8	16	5	5			
			9	16	5	5			
			10	16	5	4¾			
			..	174	..	..			

DANGEROUS PACKING MATERIAL.

Packages of nuts and other seeds are occasionally addressed to residents in Fiji from sources outside and show on opening that earth and packing material known to be capable of acting as carriers of noxious pests are often used.

This practice, in the past, has been the cause of the introduction of the Rhinoceros coconut beetle from Ceylon to Samoa. Without going outside Fiji, the regrettable introduction of such pests as the sugar-cane and the banana borers, nematodes or eel-worms, banana diseases, Koster's Curse (*Clidemia hirta*) can be directly traced to such highly dangerous packing material when handled by people who are unaware of the risk they take and expose the country to.

Instructions have been issued to examining officers, to in every case report such cases to the Department and destroy by fire any such packing and possibly after examination, the plant contents of the packages as well.

Seeds are also frequently carriers of noxious weeds. No seeds are now allowed to be introduced, even though they may be accompanied by a certificate of disinfection, until an examination of a sample submitted to the Mycologist has been examined and passed as free from foreign seed.

THE EMPIRE COTTON GROWING REVIEW.

The revival of cotton growing, a long-time Fijian industry that has lain dormant for half a century, has created a fresh interest on the part of planters to keep themselves informed with regard to the present day developments that are taking place in cotton culture, particularly within the British Empire.

To the Empire Cotton Growing Corporation has since the war been delegated the function of organising the industry within the Empire, with the result that it bids fair, within a short period of a few years, to supply not only the requirements of the British spinners but to furnish a surplus besides, to meet the needs of other countries.

The vast amount of information that has been accumulated requires making as widely known as possible and this is now being done in the *Empire Cotton Growing Review*, Nos. 1 and 2, copies of which have just been published.

The Review which is the clearing house of the very essential and practical information offered by the Empire Cotton Growing Corporation is issued quarterly and costs five shillings per annum post free and is published by Messrs. A. & C. Black Ltd., London.

MAURITIUS NEWS.

The Annual Report of the Mauritius Department of Agriculture states that the production of sugar for the 1922–1923 crop was about 60 per cent. below normal. The number of factories at work was 52, a reduction of 2. The area under cultivation is given as 170,000 acres, a reduction of 5,000 acres from the previous year. The labour difficulties and fall in price of sugar account for the decrease.

A factor of importance in easing labour tension has been the extension in the use of tractors, plough and cultivators. Of tractors there were 47 at work on various estates, of which the caterpillar type is the most popular.

The irrigation experiment station was opened last year and investigations are now being carried out as to the requirements of sugar-cane.

A large distillery and etherification plant has been completed during the year for the production of power alcohol of the Natalite type. The sugar industry is interested in its success as great economy would be effected by use of alcohol as a motive power, especially for the use of tractors on cane lands.

The mean price of sugar, which in 1920–1921 was Rs. 50·68 per 50 kilos, was set by Ordinance at Rs. 12·05 for 1921–1922, but with an improvement of the market it was anticipated the average sale price would realise about Rs. 14·70.

One insect pest of the sugar-cane, a white grub of the cockchafer family or Melolonthid beetle (*Phytalus smithi*, Arrow), was some twelve years ago detected in sugar-cane nurseries adjacent to the Pamplemouses Botanical Gardens. In spite of every effort made, the number of larvæ and of beetles dug out around the cane stools in the infested area amounted to some millions a year, the zone of infestations steadily increased. It then became evident that the pest, introduced like many others in the earth contained in Wardian cases used for introducing from abroad new varieties of sugar-cane, could not be efficiently controlled by artificial means only.

Barbados was found to harbour the same beetle as was becoming such a serious pest in Mauritius, but there it was controlled by a scoliid wasp, *Tiphia paralella*, which after several trials was introduced and became safely established. The campaign for the control of the beetle is maintained on somewhat similar lines as the Levuana moth control campaign in Fiji; out of the proceeds of a special tax of 20 cents of a rupee per ton of sugar. Whereas eight years ago the number of beetles captured within the restricted infested area was 72,000,000, the number collected annually is now gradually decreasing, and was two years ago 26,000,000.

REUNION.

To the courtesy of the Director of the *Revue Agricole de l'Ile de la Reunion* this Department is indebted for copies of the *Revue*, the official organ of the planters of Reunion. The publications, issued monthly, contain official notices, agricultural chronicles, articles on cultures and stock, from which useful topical information will be reprinted in these pages as occasion arises.

MADAGASCAR.

The *Bulletin Economique*, of Madagascar, is amongst the publications this Department gratefully acknowledges and one of particular interest. Issued quarterly it deals exhaustively with questions of Agricultural and economic importance.

The island, the third largest in the world, carries an important population engaged principally in agriculture and in stock raising, while the mining interests are being actively developed and the forests and the fisheries also occupy important places in the economics of a naturally well-endowed country.

The publication is enriched with maps, plates and with statistical tables illustrating graphically the progress of the country, its flora and its resources. Important industrial activities are represented in meat works, sugar mills, mining and other activities. The seat of Government is at Antanarivo on the elevated plateau of Imerina where the climate is cool and healthy. The white population consists of 20,000 Europeans (mostly French), 8,000 Asiatics and 3½ million Malagasi, or over one and a half head to the square mile.

CANADIAN TROPICAL IMPORTS.

The following list is illustrative of some of the products Fiji is capable of supplying to Canada; the figures refer to 1922 imports:—

Sweet potatoes		$111,726
Peanuts, unshelled	$404,926	
Peanuts, shelled, 10,351,021 lb	626,729	
		1.031,755
Oranges, California	6,399,739	
Oranges, Japanese	194,328	
		6,594,739
Lemons, California	....	1,444,762
Grape Fruit or Shaddocks, U.S.A.	....	711,993
Bananas, U.S.A.	....	5,211,098
Pineapples, fresh	$453,018	
Pineapples, canned	343,786	
		806,804
Coconut and other oils for soap making	....	1,008,897

The above represents the importation into Canada for 12 months ending 31st March, 1923, and is expressed in Canadian currency.

	Units.
Sweet potatoes	58,504 bush.
Peanuts, unshelled	5,869,658 lb
Peanuts, shelled	10,351,021 lb
Grape Fruit or Shaddocks	14,987,325 lb
Bananas	2,159,860 bunch.
Pineapples, canned	3,095,903 lb

Note.—By working out the units with the value, a fairly average price per unit can be arrived at.

AUCKLAND PRICES OF PRODUCE DURING 1923.

Month.	Bananas.	Pineapples	Tomatoes.	Kumalas.	Watermelons.	Oranges.	Mandarins.	Potatoes.	Remarks.
	Max./Min.	Max./Min.	Max./Min.	Max./Min.	Max./Min.	Max./Min.	Max./Min	Max./Min.	
Jan. 3	16/- average	not known.	....	....	....	....	....	....	
Jan. 27	15/——4/9	....	....	....	....	....	....	....	Too ripe; market glutted with local-grown fruit.
Feb. 23	14/——9/-	....	....	....	....	....	13/- aver.	....	Mandarins opened badly.
March 21	16/—13/-	....	....	....	....	12/- aver.	16/—14/-	....	
April 18	20/——1/-	....	....	....	....	7/6 aver.	7/6 aver.	....	Synchronised with arrival of Island boat, market glutted.
May 16	20/——3/-	15/- aver.	....	....	....	....	10/—4/-	....	Pineapples landed in bad condition; repacked in Auckland.
June 14	20/—17/-	15/- aver.	....	....	....	....	....	....	Mealy bug all alive and had to be fumigated.
July 10	17/——8/-	....	14/—10/-	16/—12/- sack	....	....	....	....	Mealy bug all alive and had to be fumigated.
Aug. 7	18/—10/-	....	14/- aver.	14/- aver. cwt.	....	....	....	....	
Sept. 6	21/—18/-	....	10/—9/-	18/—14/- cwt.	....	....	....	14/—10/-	Potatoes soft and spongy.
Oct. 4	25/—16/-	16/—12/-	18/6 aver.	14/——9/- cwt.	....	....	....	....	
Nov.	27/—17/-	13/——8/-	20/—17/-	18/—15/- cwt.	2/9-1/6 ea.	....	....	....	50 per cent. of one line of 287 cases bad ends.
Dec. 2	28/—20/-	18/- aver.	2/——1/-	Condemned.	2/—6d. ea.	....	....	....	Kumalas were badly infested with weevil; mealy bug all alive on pineapples so had to be re-fumigated; tomatoes arrived in bad condition, almost worthless.
Dec. 16	No prices available for "Kaiwatiri" shipment.								
Dec. 29	22/- aver.	21/—17/-	....	....	....	....	....	....	

Sizes of packages.—Banana cases, 36 in. by 12 in. by 10 in.; pineapple cases, 36 in. by 12 in. by 10 in.; tomato cases, 30 in. by 7 in. by 5 in.; citrus cases, 26 in. by 14½ in. by 6 in. (all external measurements).

Kumalas (in sacks).—Average weight about 140 lb. Potatoes (in bags).—Average weight about 112 lb.

N.B.—Coconuts prohibited unless quarantine regulations are complied with (fruit fly).

ACTUAL AND AVERAGE RAINFALL FOR THE MONTHS JANUARY—MAY, 1924.

Province.	Station.	Observer.	No. of years.	January.		February.		March.		April.		May.		Annual average rainfall to end 1923.
				Actual.	Average	Actual.	Average	Actual.	Average	Actual.	Average	Actual.	Average	
				"	"	"	"	"	"	"	"	"	"	"
Ba	Narovurovu	District Commr.	3	3·90	15·90	10·01	12·55	30·64	26·59	4·23	8·18	4·65	6·55	120·33
Ba	Rarawai	C.S.R. Coy. Ltd.	30	3·60	12·64	12·34	16·65	30·50	13·27	7·41	7·49	5·28	3·77	81·18
Bua	Nabouwalu	Roko Tui Bua...	7	3·49	12·24	13·05	12·41	20·51	13·68	3·55	12·24	17·62	8·19	106·48
Bua	Wainunu.....	S. E. Martin	45	10·05	18·92	15·00	17·47	22·60	18·45	11·75	15·61	..	..	149·09
Cakaud'e	Buca Bay	W. C. Fisher ...	12	2·98	9·47	5·96	11·42	13·77	13·11	5·03	10·69	9·97	6·99	95·96
Cakaud'e	Rabi	P. J. Lyons	20	2·75	17·51	6·61	15·40	12·17	18·64	6·53	16·59	12·64	13·77	149·00
Cakaud'e	Savusavu Bay ..	Wireless Station	18	3·45	12·60	15·14	10·28	21·40	13·30	6·80	10·02	16·78	8·50	105·04
Cakaud'e	Vuna E. Taveuni	Tarte Bros.....	5	2·18	14·92	14·71	14·36	8·37	11·50	5·82	14·71	14·90	9·26	127·55
Cakaud'e	Waiyevo, Tav'i.	Wireless Station	18	1·58	11·56	7·79	12·46	10·76	12·79	6·08	9·47	20·13	8·91	99·76
Colo N. ..	Nadarivatu.....	District Commr.	24	10·94	23·19	11·00	21·90	42·02	23·43	4·41	10·33	5·18	5·94	128·70
Colo N. ..	Tavua	C.S.R. Coy. Ltd.	18	5·07	10·74	11·25	13·10	32·97	12·90	4·33	7·12	4·13	3·84	70·83
Lau	Nabavatu	K. J. Allardyce	5	3·59	7·36	8·65	7·79	8·63	9·41	3·38	13·08	6·49	5·72	77·28
Lautoka	Lautoka	C.S.R. Coy. Ltd.	24	1·57	9·37	6·20	12·41	28·95	12·51	2·26	5·41	4·08	4·23	68·52
Lomaiviti	Levuka	Harbour Master	30	5·80	9·53	16·45	10·46	16·79	12·75	7·72	10·18	13·84	7·33	91·94
Lomaiviti	Makogai	Res. Med. Supt.	13	2·66	7·23	3·54	6·96	10·59	10·59	10·61	10·18	11·60	6·86	79·10
Nadi	Navo No. 2	C.S.R. Coy. Ltd.	23	2·47	9·57	3·26	11·57	22·11	10·37	2·38	4·90	2·94	3·21	64·03
Nadroga	Lawaqa	District Commr.	18	1·91	8·99	1·47	8·86	19·33	9·82	6·79	6·08	8·20	5·18	70·23
Rewa ...	Suva	Supt. of Agric. ..	40	9·08	13·54	11·26	10·47	13·74	15·01	10·92	12·14	17·76	10·08	115·52
Serua ...	Navua (Nai'toni)	District Commr.	8	6·05	11·31	5·26	10·58	15·47	13·76	5·76	13·93	24·89	12·82	132·34
Tailevu ..	Nausori	C.S.R. Coy. Ltd.	30	7·54	11·57	13·26	12·21	16·29	14·58	12·93	11·88	15·31	9·55	113·15
Tailevu ..	Wainivesi	C. A. Ross	2	5·16	10·41	21·42	19·67	18·87	19·95	10·31	11·57	19·56	14·67	..
Ra	Burenitu	T. Coster	6	7·40	13·20	10·67	12·00	29·11	16·63	7·84	14·91	5·91	5·42	104·26

DEPARTMENT OF AGRICULTURE.

LIST OF STAFF.

Superintendent of Agriculture	Hon. A. Despeissis, M.R.A.C. (Acting)
Editor of Agricultural Circular	do.
Government Veterinary Officer	C. R. Turbet, B.V.Sc., Sydney.
Government Mycologist	J. G. C. Campbell, B.Sc.
Government Entomologist	H. W. Simmonds, F.E.S. (Acting)
Entomologist, Levuana iridescens Control Committee.	A. M. Lea, F.E.S. (Temporary)
Cotton Inspector	B. L. Field, A.M.I.E., India.
Inspector of Produce	E. S. Gordon.
Inspector of Plantations	G. H. V. Saunders.
do.	C. T. McNamara.
Inspector of Plants (Lautoka)	R. H. Phillips.
do. (Levuka)	Capt. D. Robbie.
do. (Rotuma)	C. Jacobsen.
Inspector of Stock (Suva)	E. S. Gordon.
do. (Suva)	W. T. C. Edwards.
do. (Lautoka)	R. H. Phillips.
do. (Levuka)	A. P. Michel.
Manager, Government Rice Mill	J. P. Tarby.
Second Class Clerk	A. B. Ackland.
Clerk and Typiste	Miss M. H. Riley (Temporary)
Fourth Class Clerk	Nelson Delailomaloma.
Fifth Class Clerk	Rafaele Kurusiga (Temporary)

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